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THE VARIETIES OF SOY BEANS FOUND IN BENGAL, BIHAR AND ORISSA AND THEIR COMMERCIAL POSSIBILITIES.

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1.—INTRODUCTORY.

In 1909 the survey work on the crops of Bengal was commenced, and in July of that year a number of trial plots of the chief pulse crops of the Province were sown for identification and field study. Among these were three samples of *Bhetmas*, of which one sample of black seeded *Bhetmas*, received from the Settlement Officer, Bhagalpur, was found to be pure for seed characters and was sown as P. R. 135; the other sample which had been collected locally was found to contain chocolate and yellow seeds, and the two types were sown separately as P. R. 94 and P. R. 95. All the plots did well and were identified as varieties of the Soy Bean, but in October it became apparent that the black seeded type differed from the other two in having

* This paper was prepared for the Press in March 1912, but owing to the absence of one of the authors in England and to other causes its publication has been delayed.

darker bullate leaves and a more prostrate habit. At harvest time a limited number of single plants were selected with a view to further Botanical study. In the spring of the following year the interest taken in the Soy Bean crop elsewhere encouraged us to examine the chemical composition of these three types, and it was found that there was a marked difference in the proteid content of the types, the variation in the nitrogen content of the samples of each type being less than the differences between the means of the types.

In 1910, the seed of the single plants which had been analysed was sown together with some samples obtained by Mr. A. C. Ghosh from the Kurseong bazar and some more samples of the types already obtained from the plains. The seed of the original plots was also resown for further study. Acclimatised seed of two American varieties, Barchet and Riceland, were obtained from Saharanpur and sown for comparison with the local varieties. As a result of the year's work a distinctly earlier black seeded form was obtained from a plot (E 256 of 1910) grown from seed collected at the Bankipur Exhibition. The trial plots of the seed from Kurseong failed. More attention was paid to the chemical selection work and 150 single plants of each of the three types grown in the previous year were analysed for nitrogen and oil. The seed of each single plant derived from the seed of the original single plants selected in the previous year was again analysed. These analyses confirmed our conclusions of the previous year and showed us that the percentage oil content was also an inherited character.

In 1911, the seed of a number of the single plants analysed in the previous year was sown, and the seed of all the plants of each of the original selections was bulked and that derived from each of the original selected plants was again sown separately. These plots have again been analysed and confirm our original conclusions. In addition, the success of the plots of the acclimatized American varieties induced us to exchange seeds of the Bengal types with Mr. Piper, of the United States Plant Industry Bureau, who kindly supplied us with seed of the

varieties, Barchet, Duggar, Haberlandt, Hollybrook, Mammoth, Pekin, Pingshu. Another attempt was made to cultivate at Sabour the varieties grown in the Sikkim Himalayas, and plots of the Nepali, Barmeli, black seed, greenish yellow seed and chocolate seed varieties were obtained from Mr. Goodwin, Superintendent of the Kalimpong Homes Farm, and grown successfully at Sabour. Arrangements were also made with the Deputy Director of Agriculture for testing the yield of the Bengal types on the Department's farms. As a result of the work of these three years we have come to the conclusions, which are detailed in the following sections.

As regards the method of cultivation adopted, the land is levelled and prepared for sowing during the hot weather, and the seed sown as soon as convenient after the break of the monsoon. When the land is ready the drills are prepared four feet apart by means of the Planet Junior Hoe with plough share attachment. The seed is then sown by hand and the drills covered in with rakes. After cultivation consists in occasional hoeings with a Planet Junior Hoe (with plough share attachment), which slightly ridges up the plants and prevents water-logging. The plants are eventually thinned out to one foot apart in the rows. The rows have always been eighty-six yards long, and some four or five plots are usually sown in each row.

This work was carried out in the official years 1909-10 to 1911-12, previous to the repartition of Bengal in April 1912.

2.—NOMENCLATURE.

It is not the intention of this paper to discuss in detail the nomenclature of the Soy Bean, as that would not be possible without an exhaustive examination of the type specimens in European collections of Herbarium material. It will be sufficient to refer to some points of interest in the more important published descriptions of Indian Soy Beans which are available here. DeCandolle (1) describes *Soya hispida* Moench as an erect hispid herb. Roxburgh's (2) description of *Dolichos soja* Willd is taken

from plants grown at Calcutta from seed imported from the Moluccas, and these plants were of the twining hairy type. Wright and Walker Arnott (3) give the characters of the genus *Soja* Moench as annual, erect, flexuose, very hairy, and they mention only one species *S. hispida* Moench. In Bentham's (4) account of the cultivated *Glycine Soja* (Sieb. and Zucc.) the plant is described as villous. From Hooker's (5) description of *Glycine Soja* (Sieb. and Zucc.), it would appear that he had examined only the stout suberect type with membraneous leaves, represented in the Sikkim Himalayas by the Nepali variety. Duthie and Fuller (6) give an account of the cultivated plant under the name *Glycine hispida* Moench, and describe it as an annual, covered with ferruginous hairs, with stems stout, suberect, and climbing. Their plate represents one of the hairy twining forms found in the plains of India. Church (7) describes *Glycine soja* (Sieb. and Zucc.) as a small suberect, trifoliate, hairy, annual and gives a plate which probably represents one of the twining hairy forms commonly found in the plains. Prain (8) mentions *Glycine hispida* Maxim as a suberect annual cultivated occasionally in Western Bengal, and in another place (8a) states that a specimen of *Glycine* collected on the banks of the Ganges at Sahebganj has long trailing stems, and "but for their hispidity might pass as representing the wild G. ussuriensis."

Piper and Morse (9) come to the conclusion that the cultivated Soy Bean is *Glycine hispida* (Moench) Maximowicz, and that its nearest relative is *Glycine soja* Siebold and Zuccarini (*G. ussuriensis* Regel and Maack). They distinguish these two species by saying that *G. soja* has more slender and more vining stems, is less hairy, bears smaller pods and seeds and has smaller flowers, the calyx lobes being shorter in proportion to the tube than in *G. hispida*. They conclude that the best critical character is the length of the flower, which is 3 to 5 mm. in *G. soja* and 6 to 7 mm. in *G. hispida*, but that if this character is used *G. soja* is also a cultivated species. They consider that there is no good reason why *G. hispida* may not have been derived from *G. soja* by cultivation, the smaller flowers of the latter being the principal

difficulty. In this connection it may be noted that no differences in the lengths of the flowers of the many cultivated varieties have yet been observed at Sabour. In view of this fact and the very numerous and marked differences there are in habit, hairiness and seed characters, which will be discussed in section 3 of this paper, it would seem advisable to accept the final conclusion come to by Messrs. Piper and Morse that "on the whole, we are therefore inclined to believe that there is but one botanical species, which has been profoundly modified by cultivation."

3.—VARIETAL CHARACTERS OF SOY BEANS.

3*a*.—Habit.

In germination the fleshy oblong cotyledons are carried up above ground by the stout hypocotyl, which is usually of a purple colour. The plumule and upmost portion of the hypocotyl is hairy. The American varieties Mammoth and Hollybrook can be distinguished by their stouter cotyledons and hypocotyl. The first pair of true leaves are simple and cordate-cuneate in shape, the subsequent leaves being alternate and trifoliate In all the varieties introduced into cultivation at Sabour and on the other farms in Bengal, nodules were found to be present on the roots.

The work on Soy Beans has not progressed sufficiently far to enable us to be certain of the factors which produce the many differences of habit, but it would appear that there may be two principal pairs of characters, upright and reclining stems and branches, short and long internodes. As regards the first pair of characters, two of the varieties grown in the Sikkim Himalayas, Barmeli (type 5)* and Nepali (type 6) and all of the American varieties have upright stems, while the four types (I—IV) usually found in the plains of India have reclining branches, but of these the chocolate and yellow seeded types (III, IV) have the lower part of the main stem slightly more upright than

* Type 5 refers to the descriptive list of the types of Soy Beans cultivated in Bengal (*vide* Section 4).

in the case of the black types (I, II). In the case of the second pair of characters, the Barmeli and Nepali varieties and the American varieties Barchet, Hollybrook, Mammoth and Riceland combine short internodes (usually less than 1 inch) with the upright habit, although most of the American varieties are not pure for these characters. The Bengal types I—IV combine greater length of their upper internodes with the reclining habit. In the case of some of the American varieties (and rogues found in most of them) and also in the greeny yellow seeded variety (type III A) from Kalimpong, the upright habit is combined with long twining branches. In the rogues commonly found in the Barmeli variety the reclining habit is combined with short internodes. That there are other characters which determine the number and length of the branches relative to the main stem can be assumed from a study of plate IV of Piper and Morse's bulletin (9). A continuation of the study of the branching of the different types will undoubtedly bring to light additional characters. The importance of those mentioned above depends on the fact that the short stemmed plants mature earlier. The upright habit enables the plots of this type to be weeded more conveniently. The long much branched twining forms produce a larger number of pods per plant, and may be especially suitable for growing with maize, when they will yield well and will also not interfere with the weeding of the crop. These long branched forms are also more suitable for fodder purposes.

3*b*.—Foliage.

The chief differences found in the foliage are in the shape, size, colour, surface and degree of persistence of the trifoliate leaves. The shape of the apical leaflets may usually be described as ovate lanceolate. In the Bengal types (I—VI) the shape is approximately the same in all cases, though the later leaves of types III, IV are often narrower than the earlier leaves. In the case of the impure yellow (type III A) and chocolate seeded (type IV A) varieties from Kalimpong some narrow leaved plants have been selected. In the American varieties narrow

leaved plants are very common and one plant (E 468 of II) selected in 1910 bred true to this character in the year 1911. In size the leaves of the Barmeli and the Nepali varieties are larger than the other Bengal types. The colour of the leaves of the black seeded types (I, II) is slightly darker than that of the chocolate and yellow types (III, IV). The distinctive colour of the Nepali and American varieties is due to absence of pubescence. The black seeded types (I, II) have bullate leaves, which have hitherto distinguished them from other types, but in a natural cross (E 426 of II), this character has been found in other combinations. The upright types have upright petioles from which the leaflets are deciduous.

3*c*.—Pubescence.

The differences in the hairiness of Soy Bean varieties may be classed under two heads, the colour and the quantity of the pubescence. As regards its colour Piper and Morse (9) have shown that tawny pubescence is a Mendelian dominant to white pubescence. With the exception of Barmeli (type V), in which the hairs become whitish as the plant ripens, all the Bengal types have tawny pubescence. Differences in the quantity of the pubescence do not appear to have been noticed in America, but in the Bengal types I—V the leaves differ from the American varieties and Nepali (type VI) in being covered with soft upright hairs on their upper surfaces, whereas the upper surfaces of the leaves of the latter types are covered with closely adpressed hairs. The American varieties and Nepali can be distinguished at a distance from the fully pubescent types by the darker green colour of their leaves.

3*d*.—Flower.

1. *Morphology.*—The flowers are produced on short axillary or terminal racemes which in Barmeli are sometimes longer than in the other types.

The flowers of all the varieties grown at Sabour measured from 6 to 7 mm. The flower colour of the Bengal types I—V was purple, though the Barmeli type is slightly redder. The Nepali

type has white flowers and this colour is common among the American varieties, which are frequently impure for this character. In young buds, of which the corolla is just showing colour, the pistil projects considerably beyond the stamens as they just begin to dehisce ; but the stamens gradually elongate and in the flowers the stamens will be found to be very nearly as long as the pistil, and the stamens and pistil will be found to be completely covered with yellow pollen grains. In some cases the pollen is pushed out of the end of the keel by the elongation of the stamens. The standard forms a roof which lies close over the top of the keel.

2. *Pollination.*—Piper and Morse found the Soy Bean flower completely self-fertile, bagged plants setting pods as perfectly as those in the open ; they also found that the flowers are much visited by bees for the purpose of eating the pollen, but cross-pollination is prevented by the abundance of the pollen which covers the stigma almost as soon as the flowers open. The observations made at Sabour in 1910 showed that the seed would set perfectly well under bag, but the results of bagging were not so satisfactory in 1911, probably due to the heavier rainfall. From the above description of the flower it also appears that the stamens open early and their elongation brings large quantities of pollen in contact with the stigma ; it is therefore probable that the seeds are normally self-fertilized unless visited by insects before the pollen has come into contact with the stigma.

Observations were made by Mr. H. L. Dutt on the insects visiting the flowers, and it was found that the number of insects visiting the flowers was largest between 10 and 12 A.M. Among bees the following species were noticed :—Apis dorsata, F. ; Apis indica, F. ; and Nomia cognata, Bing. Of these, Apis dorsata was not common. It clung to the keel with its first two pairs of legs, with its abdomen hanging down below the keel, while it inserted its head between the standard and keel. Apis indica was more commonly found than the above species. Nomia cognata was the most common species visiting the flowers, as

many as six insects being found together on one plant in the mornings. Lepidoptera were represented by a few specimens of Parnara mathias, F. ; Pachyzancla stultalis, Wik, and Zinckenia fascialis, Cram. A chrysomelid beetle and Epilachna dodecostigma, Muls., were common on the leaves of the plants. Several muscid flies were almost as plentiful as the bees to which their behaviour was similar. It is probable that bees and flies sometimes cross-fertilize some of the younger flowers.

3. *Extent of Natural Crossing.*—Messrs. Piper and Morse's observations at the Arlington Experiment Station have made them conclude that even when the test rows are grown contiguously, the percentage of hybrids is perhaps not one individual in two hundred. They also find that the hybrid seed can be recognised by the presence of peculiar markings on the seed. Heterozygote plants can be distinguished by the appearance of the pods at the top of the branches, which pods are more tumid, less hairy and of thinner texture. Our observations at Sabour lead us to conclude that natural crosses do not occur on the plains of India to such an extent as in America. The three varieties which have been grown next to next since 1909 were found to be pure for all characters in that year and have since retained those characters. In 1910 eleven single plant cultures were grown of the three types I, III & IV, but no rogues were found among them. In 1911 sixty-four plots derived from single plants in 1909 or 1910 were grown in lines next to next and of these only one plot was found to be a hybrid. This plot (E 426 of II) was grown from the seed of a single plant of the yellow variety (type III), which was selected on account of its greener colour and darker hilum. Isolated rogues were also found in a few other plots and will be tested in 1912. It will probably be found that most of them are chance admixtures. A statement of the rogues found in 1911 is given below. In all, 3,587 plants were harvested from unbagged seed grown from single plants in 1910. Column 3 gives the number of years during which each single plant culture has been grown.

1 Field number.	2 Description.	3 Period of Exprt.	4 Composition of plot.
E414 of 1911 ...	Type III (yellow) ...	2nd year .	180 plants, seed yellow, hilum pale brown. 1 seed yellow, hilum browner.
420 of ,, ...	Ditto . .	1st ,, ...	4 ,, ,, ,, pale brown. 1 ,, ,, ,, browner.
430 of ,, ...	Type IV, chocolate ...	2nd ,, ...	181 ,, chocolate. 3 ,, black.
432 of ,, ...	Ditto ...	2nd ,, ...	160 ,, chocolate. 1 ,, greeny yellow. 1 ,, black
438 of ,, ...	Ditto ...	1st ,, ...	88 ,, chocolate. 1 ,, yellow.
426 of ,, ...	Greeny yellow, hilum dark brown.	1st ,, ...	7 ,, black. 2 ,, chocolate, hilum chocolate. 9 ,, greeny yellow clouded black hilum black. 3 ,, greeny yellow clouded chocolate, hilum chocolate.
466 of ,, ...	Barchet	1st ,, ...	6 seed dull olive brown (Barchet). 1 ,, ,, black (Riceland).

It is interesting to note that the American varieties and those obtained from Darjeeling district were full of impurities, whereas all the samples of seed (pure for seed characters) collected in the plains have been found to be pure for vegetative characters also. It may be that crossing occurs more frequently in the more temperate climate of America and the Darjeeling Himalayas.

3*e*.—Pods.

No marked differences have been noticed in the shape or size of the pods of the varieties cultivated at Sabour. The differences in the colour of the pubescence have been noted above. The colour of the pods differs from the usual yellow colour in some cases. The Barmeli type resembles the American varieties Mammoth and Hollybrook in having whitish pods, and the Riceland variety differs from Barchet in having darker brown pods. The pods appear to shatter less easily in the twining types (I—IV) than in the upright varieties. From one to three pods are usually produced by each inflorescence, though this number is often increased to seven in the case of the Barmeli type. The pods never contain more than from one to three seeds in the types examined.

The production of pods per plant differs markedly in different types depending on the extent of branching of the plant. In the upright types with few short branches, the maximum number of pods produced in a well developed plant very seldom exceeds five hundred and in good average specimens of the Barchet, Riceland and Barmeli varieties, it is probable about two hundred and fifty, yielding about 40 grams of seed. In the Nepali type grown at Sabour about fifty pods were produced on each plant. The longer and more profusely branched types (I—IV) can produce up to a maximum of one thousand five hundred pods, yielding up to 175 grams of seed per plant. The yellow and chocolate types (III & IV) also have given the best yields in the Botanical test plots producing about 50 grams of seed per plant, while the black types produced only about 30 grams per plant. The actual figures obtained in field trials (about ·25 acre plots) of the three types are given in the statement below :—

Plot.	Plants counted.	Pods per plant.		Weight of seed per plant average of 100 plants.	Yield per acre.	Remarks.
		Extremes.	Mean.			
Type 4 chocolate.	12	135—1312	557	32 grams	13 mds. 16 srs.	1 md. = 82⅔ lbs. = 40 srs.
Type 3 yellow	12	71—911	392	23·5 ,,	10 ,, 39 ,,	
Type 1 black	12	90—670	200	13 ,,	5 ,, 39 ,,	Germination poor.

The figures for the number of pods per plant found in the Bengal types may be compared with the average yield of pods per plant given by Shaw (10) from the Tichling district of China—

1908	...	35— 80 pods per plant.
1909	...	40— 76 ,, ,, ,,
1910	...	42—105 ,, ,, ,,

The results of our observations on pod production would appear to indicate that it will be desirable to raise types

combining the upright habit with the capabilities of producing the higher orders of branching possessed by the Bengal twining types (I—IV). It should be noted that the production of pods in the best of the types at present under cultivation compares favourably with that of the field peas of which the weight of seed per plant has not been found to exceed 150 grams per plant, and is distinctly superior to that of other Indian Kharif pulses except Rahar (Cajanus indicus).

3*f*.—Seeds (Morphology).

In shape the seeds are usually elliptic in outline, the thickness being less than the breadth ; but the seeds vary in thickness from the much flattened seeds of the black twining varieties (types I, II) to the Nepali variety which is round in section.

The size and weight of the seed vary considerably, the lowest weight per hundred seeds being less than 4 grams in the case of the twining types I—IV, and as much as 24 grams in the case of Nepali. Hooper (11) observed that black seeds collected from the hills are heavier than those collected in the plains. Our observations also show that the black seeded variety (type I A) obtained from the hills which appears to be practically the same type as that cultivated in the plains (type I) has a weight per 100 seeds of 6·25 grams, but after one season's growth it has been reduced to 5·5 grams per 100 seeds, as compared to an average of 3·9 for the plots of the local variety. The greeny yellow (type 3 A) and pale chocolate (type 4 A) varieties introduced from the hills have behaved similarly, but these differ from the yellow and chocolate varieties of the plains in vegetative characters. The early black twining type (type I) obtained from Patna has increased in weight from 3·2 grams per 100 to 3·9 grams under cultivation at Sabour. The weight of 100 seeds in some of the American varieties such as Barchet, Pekin and Pingshu has remained approximately constant, whereas others, such as Duggar, Hollybrook and Mammoth have decreased in weight more or less considerably during the past season. The Nepali type has decreased in weight from 24·4 grams to 12·8

grams per 100 seeds. The variation in weight per 100 seeds in the case of varieties cultivated in new localities would appear to give a good indication of the adaptability of a variety to its new environment.

There are many characters for seed colour, the local types being either black, chocolate or yellow. Yellow seeds may have more or less of a greenish tinge. In one Darjeeling variety the seeds are greenish yellow. In the case of the chocolate and yellow seeds there may be subtypes in which the colour is paler. A dark coloured seed coat may be a disadvantage if a white meal is required. The hilum may be of the same colour as the rest of the seed coat or the black or chocolate colour of the hilum may merge into the yellow colour of the rest of the seed coat. In these cases the hilum colour usually spreads out to form an uneven band round the hilum of greater or less width. The colour of the germ was yellow in all the varieties examined.

3*f*.—Seeds (Composition).

Owing to the fact that the Soy Bean has recently come into prominent notice from its value as a food-stuff and also as an oil-yielding crop, it will be unnecessary to dilate upon these uses, as many able writers have called our attention to the use of Soy Beans for both purposes. In recent years Hooper (11) has published numerous analyses of Soy Beans from various parts of the world, a large pamphlet has been published upon the crop by the Imperial Chinese Customs (10) and numerous Bulletins, principally dealing with the purely botanical or agricultural side of the question, have been issued by the United States Department of Agriculture.

All chemical work published up to the present, however, appears to have been done on the broad lines of analyses of bulk samples introduced from different parts of the world and very little care appears to have been taken to ensure the purity of the types analysed. It was thought that it might prove of interest to examine the chemical characteristics of certain varieties grown from the seed of single plants.

In consequence several observations were made upon small quantities of seed obtained from single plants in 1909. Owing to the fact that a proportion of the seed was required for sowing again in the following year, the sizes of the samples were very small and we were only able to determine the nitrogen in small quantities of seed from each plant. From five to seven seeds were taken in each case, and the nitrogen was determined by Kjeldahl's method. It will be seen that it was impossible to arrive at definite conclusions from observations of such extremely small samples, which did not exceed 0·4 gram in weight in any case. Owing, however, to the fact that they were the starting point of our work, it will be of interest to give the results obtained from these experiments.

These results were as follows :—

Colour of Beans.	Original No.	Nitrogen content.	Variation from Mean.
Black (type 1) ...	135 A.	6·08	−·06
	135 B.	5·92	−·22
	135 C.	6·43	+·29
	Mean ...	6·14	
Yellow (type 3) ...	95 A.	5·99	+·15
	95 B.	5·93	+·09
	95 C.	5·60	−·24
	Mean ...	5·84	
Chocolate (type 4) ...	94 A.	5·32	+·20
	94 B.	5·44	+·32
	94 C.	4·83	−·29
	94 D.	4·74	−·38
	94 E.	5·28	+·16
	Mean ...	5·12	

The great difference in nitrogen content between the black and chocolate varieties led us to think that it would be of interest to see if these differences were merely accidental or were inherited characters of the varieties.

Owing to the small size of the samples, to which reference has already been made, it was thought that it would be of interest to corroborate our observations by an examination of

large bulk samples from the plots from which these single plants had been selected.

The results obtained were as follows :—

Colour.	Nitrogen. Per cent.
Black	6·17
Yellow	5·44
Chocolate	5·74

Although these plots were not grown from single plants, yet they appeared to be perfectly even, and these results, in which the black seed stood out ahead of the other two as regards its nitrogen content, tended to corroborate our observations on the small samples obtained from the single plants. Consequently in the rains of 1910 we resowed not only the seeds of the singly selected plants, but also seeds from the original plots from which they were chosen.

The descendants of the former were analysed plant by plant and the means are shown in the tables (Tables I—IV), giving their history for the past three years. From the descendants of the latter, 150 plants were taken from each plot for analysis (Tables V—VII).

The results of these analyses are striking, and are of additional interest in that we were able this time to determine the oil contents of a great many specimens. In order that reference may be made to these tables, they are published at the end of the letter-press.

On collecting the results we were still further strengthened in our belief that it was possible that certain differences in oil and nitrogen content might be correlated with certain definite vegetative characters.

Firstly, in considering the nitrogen contents of three varieties, we can arrange them in the following tabular statement showing the groups into which the samples of each variety may be arranged according to their nitrogen content (*see page* 118).

Tabular Statement showing grouping of samples of Seeds of Soy Beans according to their nitrogen content.

	4			5										6										7						
	·7	·8	·9	·1	·2	·3	·4	·5	·6	·7	·8	·9		·1	·2	·3	·4	·5	·6	·7	·8	·9		·1	·2	·3	·4	·5	·6	·7
Black ...	...	...	...	...	...	...	...	...	..	...	...	...	1	1	5	10	12	5	16	17	12	12	7	12	11	4	7	4	1	3
Mean 6·72% ...	...	...	...	...	...	...	...	...	...	...	...	...	1	6		22		21		29		19		23		11		5		3
Yellow ...	...	...	1	2	3	2	6	12	18	22	20	26	20	9	4	4	..	...	...	...	...	...	...	..	...	...	...	...	...	...
Mean 5·61 ...	...	...	..	5		8		30		42		46		13		4	...	...		...		...		...		...		...		...
Chocolate ...	...	1	2	4	2	4	11	9	22		17	14	11	15	12	5	1	2	...	...	...	..	..	..	...	...	...	...	...	...
Mean 5·59 ...	...	3		6		15		31		29		25		27		6		2	..	...	...	...	...	...	...	...	...	...	...	...

From this we see that in 1910 the black seeded variety showed a tendency to group round the high nitrogen values while the yellow and chocolate varieties, although nearly equal to one another, were far below the black.

The actual means were as follows :—

Variety.	Nitrogen content.	Probable error of mean.
	Per cent.	
Black (Type 1) ...	6·72	± ·02
Yellow (Type 3) ...	5 61	± ·02
Chocolate (Type 4) ...	5·57	± ·02

The fluctuations from the mean were extremely small. The standard deviation was about ± ·3 and the probable error of a single sample was therefore about ± ·2.

Actual examination of the results obtained showed the following :—

Variety.	Mean ± ·2.	Outside mean ± ·2.
Black	64	76
Yellow	86	63
Chocolate	76	68

It has been mentioned that in 1911 we were able to determine the oil contents of each type of seed. For this purpose about 70 plants of each kind were taken at random and their oil content was determined. In this case it was found that the yellow and chocolate coloured varieties were by far the greatest in oil content, while the black seeds were in nearly every case far below them.

The means obtained were as follows :—

Variety.	No. of samples.	Mean oil content.	Probable error of mean.
		Per cent.	
Black	77	13·52	± ·08
Yellow	65	16·99	± ·07
Chocolate	68	17·13	± ·09

Now from the data at our disposal we were able to draw certain frequency curves for each variety.* These curves illustrate very clearly the fact that while the black seeds tended to have higher nitrogen values than the others, exactly the contrary was the case with regard to the oil values. Reference will be made to this later.

It has already been mentioned that in addition to these experiments undertaken in 1910 the actual descendants of the single plants originally analysed were sampled and their nitrogen content determined immediately.

Owing to lack of time at our disposal we were not able to determine the oil content of these plots, but observations on their nitrogen content led us to believe that they were not in any way different from the groups in which a determination of both nitrogen and oil was made.

It would appear, however, that in 1910 the nitrogen content of the black soy beans was abnormally high. This was not only the case in one plot, but was found in every single plot analysed. Such variations are only to be expected as the character of the season varies from year to year.

From the experiments made during the three years over which the crop has been under observation, however, it would appear extremely probable that the tendency of the black seeded variety is to maintain a high percentage of nitrogen and low percentage of oil, while the other two varieties probably have a tendency in a similar degree to give lower percentage of the former and higher of the latter constituent. There appears to be in fact little difference between the so-called chocolate and yellow varieties as will be seen from the table already shown. This is of great interest when viewed in conjunction with the fact that the vegetative characters of the yellow and chocolate varieties, apart from the seed colour, appear to be similar, and distinctly different from those of the black. From this we are led to believe that such characteristics as the oil and nitrogen content of the crop may be correlated with actual vegetative characters.

* These curves are shown at the end of the Memoir.

That each variety contains unit species which differ in their nitrogen and oil content from the mean of the variety is not only extremely unlikely but is negatived by certain experiments made by us on certain seeds which were found to differ widely from the normal (*vide* Tables I, II and III).

It will be seen from what has gone before that the variety, having a high oil content had a low nitrogen content, and that the contrary was also the case. This led us to wonder whether the differences observed in 1910 and more carefully in 1911 might have been due to some external cause which increased the formation of nitrogen and at the same time decreased the formation of oil. If this were the case the correlation between nitrogen and oil content in any single variety should have a very high negative value. The correlation was in consequence worked out in each variety by the usual formula.

The results in each variety were very similar in magnitude. They were as follows :—

Variety.	Correlation Factor.	Probable Error.
Black (Type 1) ...	−·25	±·07
Yellow (Type 3) ...	−·34	±·07
Chocolate (Type 4) ...	−·33	±·07

There is therefore an indication of a slight negative correlation between the nitrogen and oil contents, but from these data they cannot be considered to be complementary to one another. In other words it is extremely improbable if, by some external cause, we were to be able to increase the average nitrogen content of the yellow soy bean crop until it reached the average observed by us in the black seeded variety, that the oil content would diminish at the same rate. Some slight correlation is naturally to be expected, as the increase in one form of energy supply is likely to be balanced by a decrease in the other form ; but the above relations point clearly to the fact that the correlation is not by any means absolute. In addition to this another test was made by bringing into consideration the

size of the seeds whose oil content had been determined. If external conditions affect the plant at all, they are very likely to show their action upon the weight of the individual seed, or upon its total yield. As a case in point, we may instance a soy bean (Type VI Nepali) whose seeds when grown at Sabour are only half the weight of those grown in the hills.

From about 50 samples of the same type the correlation factor between the size of seed and oil content is found to be extremely small.

Hence it follows that although in the case of three definite types of soy beans the mean oil content was found in two cases to be relatively high and the nitrogen content was low, while in the remaining unit species the reverse phenomenon was observed, yet in any particular type there was not any great indication of the dependence of oil and nitrogen content upon one another or upon such external conditions as would modify the size of the seed. We are, therefore, led to believe that in the three types studied, the percentage content of nitrogen and oil is in all probability a characteristic that is inherited and that the variations which we have observed have been purely due to the differences in the types examined, and not to external causes.

Finally in 1911 the means of the bulked plots from the seed of single plants were found to be as follows :—

Type.	No. of plots.	Nitrogen content. %	Probable error of mean.	Mean oil content. %	Probable error of mean.
I Black ...	15	6·32	±·06	12·85	±·13
III Yellow ...	12	5·68	±·03	16·65	±·10
IV* Chocolate ...	33	5·95	±·03	16·20	±·10

* This includes 24 separate plots each grown from single plants grown from the original No. 94C. The results of each of these plots are given in Table IV.

From this it will be seen that the mean nitrogen content of the black type again far exceeds that of the others, while the differences as regards oil content are almost identical with those observed last year.

The actual divergencies from the mean were very small and were in most cases within the limits of experimental error. Taking for instance the case of the black soy beans, of which mean nitrogen content was 6·3% (approximately), we find that out of 15 determinations 13 were within the limits 6·3 ± ·2%, and each of the fifteen came within the limits 6·3 ± ·3%. In the same way the mean of the results obtained with the yellow soy beans was 5·7% (approximately), and out of 12 plots sampled and analysed 10 were within the limits 5·7 ± ·2% and the whole twelve came within the limits 5·7 ± ·3%. Again in the chocolate coloured variety we find that out of 33 plots sampled and analysed, whose mean nitrogen content was approximately 6%, 26 came within the limits 6 ± ·2% and 30 within the limits 6 ± ·3%.

From this it follows that the variation in nitrogen content of individual plots was very small, and for all practical purposes may be considered to have been constant over the whole field. A similar constancy is observed in the oil determination, but of necessity cannot be so striking, owing to the fact that the methods used in the determination of oil are by no means so accurate as those used for the estimation of nitrogen.

3*g*.—Maturity.

The life period of the different varieties of Soy Beans varies over a wide range. Piper and Morse (9) state that the early American varieties ripen in eighty days and the latest varieties in over one hundred and fifty days, while we have found that the varieties (Types I—IV) found in the plains of Bengal take as much as two hundred days to mature. These types do not reach maturity in America. These late types have a serious disadvantage in that they remain on the land during both the rainy and cold seasons so that only one crop can be taken on the land during the year, but, on the other hand, they would appear to produce more pods per plant than the earlier types. Before Soy Beans can be recommended for cultivation in India on a large scale

it will probably be necessary to introduce satisfactory early types.

Soy Beans are grown during the rainy season in Bihar. The local varieties (Types I—IV) resemble the other *Bhadai* pulse crops in that they ripen off at the same time of year irrespective of the date on which they are planted. These late varieties normally ripen after the middle of December, but can be sown from the end of May to the beginning of September. If they are planted late in September or early in October the size of the plant is much reduced and the date of harvesting may be somewhat later. The varieties grown in the Darjeeling hills have a somewhat shorter period of growth and were ripe in November at Sabour in 1911. None of these short season varieties have been found to have spread into the plains. A statement is given showing the life periods of the Bengal types. (Table VIII.)

As a result of some observations made by Ball (12) and Piper and Morse (9) in America it has been thought that a variety may progressively change from early to late, but the evidence is at present by no means conclusive. The observations made by us at Sabour show that newly imported American varieties take a considerably shorter time to mature at Sabour than in America, but that plants from acclimatized seed mature somewhat later than those from freshly imported seed. A statement of our observations is given below :—

Life periods of American varieties of Soy Beans grown at Sabour, 1911.

Variety.	Origin.	Date of planting.	Date of harvesting.	Life period at Sabour.	Life period in U. S. A.	Remarks.
Barchet ...	S. P. I. No. 23232	July 12	Oct. 18—28	99—108 days.	Over 150 days.	
Do. ...	Acclimatized from Saharanpur.	,,	Nov. 9—17	120—128	do.	
Duggar ...	S. P. I. No. 17268c	,,	Oct. 11	91	110—120	
Haberlandt ...	S. P. I. No. 17271	,,	Oct. 31	111	120—130	
Hollybrook ...	S. P. I. No. 17278	,,	Oct. 19	99	130—150	
Mammoth ...	S. P. I. No. 30205	,,	Oct. 25	105	130—150	
Pekin ...	S. P. I. No. 17852B	,,	Sept. 30	80	.....	
Pingshu ...	S. P. I. No. 18259	,,	Sept. 25	75	.....	
Riceland ...	Acclimatized seed from Saharanpur.	,,	Nov. 13	124	Over 150	

3*h*.—Diseases.

Soy beans do not appear to suffer much from diseases, though a portion of the chocolate-seeded plot was wilted by Fusarium sp. in 1909, and again in 1911 a portion of one of the chocolate-seeded plots was attacked. A leafspot disease caused by a species of Cercospora produces brown spots on the leaves and weakens the plants somewhat. No very serious damage to the plots at Sabour has been done by insect pests though surface grasshoppers (Chrotogonus trachypterus) do some damage to the young seedlings, and it is necessary to keep picking off the young broods of the Bihar hairy caterpillar (Diacrisia obliqua) as they appear. Mr. Dutt has also observed groundnut leaf roller (Anarsia ephippias) on soy beans at Pusa. One of the great merits of the soy beans examined at Sabour is the entire freedom of the stored grain from weevils, a fact which is of interest in view of Shaw's (10) statement that in China "worms and weevils do damage to the seeds after harvest."

4.—DESCRIPTION OF TYPES.

It has been thought advisable to describe the chief types of soy beans isolated up to the present time (season 1911) in order to record the characters of the types on which the chemical selection work has been carried out. In the course of a few years, when the various combinations of the very large number of unit characters have been isolated, it is probable that a very large number of types will be known.

Type I.—"*Kala Bhetmas.*"

Stem and secondary branches long, weak, reclining, some tertiaries ascending. Leaves bullate. Stems, leaves and pods with tawny pubescence. Flowers purple 6 to 7mm. long, usually sessile in short racemes. Pods 1·3″ to 1·7″ long, 1—3 together, seeds black, 4 to 6·5 mm. long by 3 to 4·5 mm. broad, elliptical, much flattened, germ yellow. Seeds contained 6·1 to 6·6% nitrogen and 11·2 to 13·5% oil in 1911.

The habit of plants of this type is quite distinct. The main stem and secondary branches lie along the ground, but some of

the shorter tertiary branches are more ascending and attain to a height of about 18 inches from the ground. A plot of this type is slightly taller than the early black but lower than the other types. Measurements were made of a typical plant at the end of September, and a main stem of 26 internodes was 33 inches long, the secondary branches were produced from the 2nd to the 17th node and measured up to 32 inches, the lower internodes of the main stem were less than 1 inch and the upper ones as much as 3·5 inches long. The reclining stems often root at the nodes. Red stains are often produced wherever the stems are injured. The lower leaves are usually darker green, and a typical measurement of an apical leaflet of a leaf subtending of a lower branch is 3·7 inches by 2·3 inches. The leaves at the apices of the branches are slightly smaller (3·3 inches by 1·6 inches), are distinctly bullate and are usually dotted with yellow. The whole plant is covered with tawny pubescence. The plants commence flowering at the end of September and are usually in full flower at the beginning of October; the terminal inflorescences are produced at the end of October and the pods ripen by the middle of December. The brownish pods are slightly curved and from one to three seeded. Not more than three pods are usually produced on one raceme. Unripe seeds are larger and purple in colour but become blacker and smaller as they ripen. The weight of seed produced per plant for an average of about 250 plants grown in the Botanical Experiment Area in 1911 worked out at 25 grams per plant. The weight of 100 seeds varies from 3·2 to 4·9 grams (mean 3·9). In connection with the fact that the seed has given a consistently high percentage of nitrogen, it is interesting to note that the prepared *dal* is considered by cultivators to be more heating than that of the other varieties. This type has been collected most frequently at exhibitions in the province. It has been grown at Sabour during the seasons 1909, 1910, 1911, and has kept its distinctive characters.

It appears to be grown as a pure crop without impurities, though types which vary in their time of ripening may occur. **(Plate I).**

Type 1A. A batch of similar but slightly larger seed obtained from Darjeeling was found also to have bullate leaves, but to be made up of a number of constituents differing in time of ripening, the seeds were larger than the acclimatized type and weighed from 3·75 to 5·90 grams per 100. This variety is listed as variety 3 by Goodwin (13) in the Bengal Quarterly Journal, Vol. IV, No. 3.

Type 2.—"*Kala Bhetmas.*"

Stem and branches long, weak, reclining, leaves bullate. Stems, leaves and pods with tawny pubescence. Flowers purple, 6 to 7 mm. long, usually sessile in short racemes. Pods 1·2 to 1·5 inches, 1-3 together. Seeds black, 3·5 to 7 mm. long, by 3 to 4·5 mm. broad, elliptical, much flattened. Germ yellow. The seeds contained 6·1 to 6·5 per cent. of nitrogen and 12·4 to 14·3 per cent. oil in 1911.

This type differs from Type 1 only in having a more prostrate habit and in ripening considerably earlier. When this type was first selected the seed was found to be smaller than that of Type 1, but this difference has disappeared during its second year of cultivation. In 1910 seven individual plants of this type gave an average weight per 100 seeds of 3·2 grams (extremes 2·45 to 3·9 grams), whereas the offspring of these 7 plants in 1911 gave an average weight of 100 seeds of 3·9 grams (extremes 3·4 to 4·25 grams) which is the same as that for Type 1. This type can be distinguished from Type 1 in the field by its lower habit of growth, but it is extremely difficult to give a morphological explanation for the difference. The chief difference between the two types lies in their period of maturity. In 1911 the plots of Types 1 and 2 were both sown on July 12, but Type 2 was in full flower on September 24, whereas Type 1 did not commence flowering until October 3. Type 2 was ripe on December 5 and Type 1 on December 15. This type was obtained from Bankipur Exhibition in 1910 and has been under observation for two years.

Type 3.—"*Safed Bhetmas.*"

Basal portion of stem stout upright, apical portion weak, reclining, secondary branches long, weak, reclining, some tertiaries

ascending. Stems, leaves and pods with tawny pubescence. Flowers purple, 6 to 7 mm. long, sessile in short racemes. Pods 1·3 to 1·7 inches, 1-3 together. Seeds pale yellow, greenish when immature, 4 to 6·5 mm. long by 3 to 4·5 mm. broad, elliptical, flattened. Hilum brown, brown colour extending outwards in a band round the hilum. Germ yellow. Seeds contained 5·4 to 5·9 per cent. nitrogen and 15·5 to 17·5 per cent. oil.

This type and Type 4 are similar except in the colour and composition of the seeds. Their habit is markedly different from that of Type 1. The main stem is usually stout and upright below, but its upper portion and the secondary branches bend down towards the ground. Some of the branches of the higher orders are more ascending. The length of the stem and branches is similar to that of Type 1. In vigorous plants the main stem is erect to a height of about 1 foot and then the main stem droops over, the branches ascend for a few inches and then also droop, their apices lying along the ground. In thickly sown plots the plants grow up straight to a height of about 18 inches and then the stem and two or three long unbranched secondary branches droop down towards the ground. The flowers are concealed beneath the leaves and are not so readily noticeable as in the black types. The reclining stems often root at the nodes. The leaves are flat and somewhat larger than those of Type 1, well developed apical leaflet measuring about 4 inches by 2 inches. The colour of the leaves is also lighter green than in Type 1, but this character is only apparent in the field. The whole plant is tawnily pubescent. The ripening plants when bare of leaves can be distinguished from Type 1 by their brighter yellow colour. This type matures slightly later than Type 1. In 1911 the terminal inflorescences were not produced until November 13, whereas Type 1 had commenced to produce terminal inflorescences on October 27. The pods are ripe by about December 20. This type is usually found growing mixed with Type 4 from which it cannot be distinguished in the field. It was originally obtained from Sankarpur *dearh* near Bhagalpur and has been grown at Sabour

for three years. The brownish pods are slightly curved and from 1—3 seeded. Not more than 3 pods are usually produced on one raceme The average yield per plant from 500 plants cultivated in the Botanic Experiment Area in 1911 worked out at 49 grams per plant. The weight of 100 seeds varies from 4·8—5·95 grams (mean 5·45 grams).

Type 3*a*.

An impure variety with greeny yellow seeds and a broad brown band round the hilum was obtained from Kalimpong and grown at Sabour in 1911. It was found to be extremely impure, plants differing in having tawny or whitish hairs, stout, short, upright or long twining upright branches and broader or narrower leaves. In the majority of the plants the branches were very numerous, long, thin, upright and twining at the ends. This is variety 1 of Goodwin's list (13), in which it is stated to have the finest flavour of the Darjeeling varieties. It was grown at Sabour in 1911. (Plate III).

Type 4.—"*Lal Bhetmas.*"

Basal portion of stem stout, upright, apical portion weak, reclining ; secondary branches long, weak, reclining ; some tertiaries ascending. Stems, leaves and pods with tawny pubescence. Flowers purple, 6 to 7 mm. long, sessile in short racemes. Pods 1·3 to 1·7 inches, 1-3 together. Seeds chocolate, 4 to 6 mm. long by 3 to 4·5 mm. broad, elliptical slightly flattened only, hilum slightly lighter chocolate. Germ yellow. Seeds contained 5·6 to 6·1 per cent. nitrogen and 15·6 to 17·3 per cent. oil in 1911.

This differs from Type 3 only in its seed characters. The red stains marking injuries to the stem of the type already noticed in the case of Type 1 were also noticed in some plants, and may perhaps be due to the same factor which produces the dark colour of the seed coat in these two types. The average yield per plant of nearly 1,500 plants cultivated in the Botanic area in 1911 worked out at 53 grams per plant. The weight of 100 seeds varies between 4·41 and 6·5 grams (mean 5·53 grams). In field cultivation it appears to be usually mixed with Type 3.

Type 4*a*.

A somewhat similar impure variety has also been obtained from Kalimpong. It has pale chocolate seeds and is listed by Goodwin as variety 2. It differs from the Bengal Type 4 in having seeds of lighter colour, comparatively few long twining branches which lie along the ground, and in ripening considerably earlier. The leaves in some plants were also narrower. The seeds are also heavier than the local variety but have decreased in weight under cultivation in the plains. It was grown at Sabour in 1911.

Type 5.—"*Barmeli Bhetmas.*"

Stems short, stout, upright; secondary branches upright ascending close to stem. Stems, leaves and pods covered with tawny pubescence. Flowers purple, 6 to 7 mm. long, peduncled on longer racemes. Pods 1 to 7 together. Seeds bright yellow, 4·5 to 7·5 mm. long by 3·5 to 5·5 mm. broad, elliptical, flattened, hilum only brown. Germ yellow. Seeds contained 5·33 per cent. nitrogen and 16·96 per cent. oil in 1911. (1 sample only.)

This type is of erect habit, the stem usually consisting of about 21 nodes and measuring up to 28 inches; the lower branches do not usually exceed 11 inches (8 nodes), but in particularly tall and vigorous plants upright branches of length 31 inches have been noted. The upper branches usually consist of one or two nodes only; the branches ascend close to the main stem. The leaves are large, an apical leaflet measuring 4·8 by 2·7—5 inches and are covered with longer and more upright hairs than in other types. The plot sown at Sabour on July 12, 1911, was in flower on September 24 and some plants were ripe on November 18, though the bulk of the crop was harvested on December 9. The flowers are produced in rather elongated racemes on which from 1 to 7 pods are produced. The ripe pods are whitish and covered with pale yellow hairs. The crop when dead ripe has a distinct whitish appearance. The weight of seed per plant produced by 20 good average plants was at the rate of 42 grams per plant, whereas that for 100 average plants was at the rate of 20 grams per plant. The weight of 100 seeds was 8·25 grams when

growing at Kalimpong, but fell to 7·4 after cultivation at Sabour.

This type is grown at Kalimpong and was grown at Sabour and on all the Bengal farms in 1911. The variety was listed as variety 4 by Goodwin (13) in the Report of the Kalimpong Farm for 1910-11. Commonly a weak plant with thinner prostrate or partially ascending stems and smaller leaves, but similar as regards period of maturity, shortness of nodes, pubescence, and seed colour, is found in this crop. (Plate II).

TYPE 6.—"*Nepali Bhetmas.*"

Stems short, stout, upright; secondary branches short, upright ascending close to stem. Leaves nearly glabrous, stems and pods covered with tawny pubescence. Flowers white, 6 to 7 mm. long, sessile in short racemes. Pods 1 to 3 together. Seeds brown, 8 to 10 mm. long, by 6 to 8 mm. broad, oval not flattened, germ yellow. Seeds contained 5·72 per cent. nitrogen and 20·04 per cent. oil.

This type has a short, stout, upright stem varying in length from 6 to 15 inches, the branches are few and short, the lower branches not exceeding 6 inches in length and the upper being considerably shorter; they make an angle of less than 30° with the main stem. The stems are brownish and covered with tawny pubescence. The leaves are flat, covered with closely adpressed hairs and dark green in colour, they vary in size from 3 inches by 1·8 inches to 5 inches by 2 inches broad. The leaflets are deciduous from the upright petioles. The plot planted at Sabour on July 12, 1911, was in flower on September 6 and was ripe by October 30. The pods are brownish and covered with tawny pubescence. Sixty-five plants of the general crop of this variety in 1911 produced seed at the rate of 5 grams per plant only. The seed grown at Kalimpong weighed 24·4 grams per 100 seeds, while that grown at Sabour was shrivelled and pitted and only weighed 12·8 grams per 100.

This type was obtained from Kalimpong and was tested at Sabour in 1911. It is listed as variety 6 by Goodwin in the

Report of the Kalimpong Farm for 1910-11, where it is stated that this variety is cultivated at higher altitudes than the other varieties. It does not do so well when sown as a mixed crop with maize as when grown by itself. (Plate III).

5. DISTRIBUTION.

Decandolle (14) came to the conclusion that soy beans are a modern introduction into India, because Roxburgh had only seen an introduced plant in the Calcutta Botanic Gardens. Our observations show that the black, chocolate, and yellow seeded varieties of soy beans (Types I—IV) are cultivated under the name Bhetmas to a very limited extent indeed in the plains of Bengal. The only plots which we have actually seen growing have been in the neighbourhood of Sabour from seed stolen from the Botanical area. Samples of the seeds have, however, been met with at exhibitions in Bihar, Orissa and Chota Nagpur. In the Sonthal Parganas the yellow and chocolate varieties are cultivated with cotton and are called Disomhorac. It is, therefore, possible that soy beans may have been cultivated in the plains before Roxburgh's time, but escaped his notice owing to the extremely limited extent of their cultivation. In the hills the following five varieties, black seed (Type 1A), greeny yellow (Type IIIA), pale chocolate (Type IVA), Barmeli and Nepali, are cultivated to a small extent and of these the Barmeli variety would appear to be the commonest. Soy beans can be cultivated up to an elevation of 6,000 feet where Phaseolus Spp. will not thrive.

With regard to their distribution it is interesting to note that all the varieties cultivated in the plains are pure, whereas those cultivated in the hills are usually very impure. The types present in the plains are all late varieties with long twining branches, tawny hairs and purple flowers, whereas the Darjeeling varieties appear to contain plants exhibiting many other characters such as upright habit, white flowers, adpressed hairs on the upper leaf surface, white pubescence and various seed characters which are present in the Chinese varieties introduced into America. The time of maturity of the Darjeeling varieties also

varies. These facts make it seem probable that the Darjeeling varieties were originally obtained from China through Tibet, and have spread thence into the plains, where only these types best adapted to the plains have survived.

Shaw (10) states that in China "the further north they extend the better in quality do the beans become." Our observations show that the seed of a variety cultivated in the Himalayas is heavier than the seed of the same variety cultivated in the plains It is probable therefore that soy beans find more suitable conditions in the hills than the plains, and this would account for their having spread outwards for a short distance only from the foot of the hills. We cannot therefore expect to obtain much success in acclimatizing soy beans, except along the foot of the Himalayas and our greatest chance of introducing the crop successfully will be in the Himalayas.

6. CULTIVATION.

In the plains soy beans can be grown alone or with maize, or cotton. They will grow satisfactorily on high lands and do not necessarily require manure. The land should receive some 3 or 4 ploughings and should be clean and in good tilth. The seed may be sown broadcast at the rate of 10 seers or in drills two to three feet apart according to variety at 6 seers per acre from the break of the monsoon to the end of July, though a smaller crop could be obtained from seed sown up till the middle of September. Shaw (10) states that in China the seed is sown by hand on top of drills and covered by hand. The crop is benefited by one or two hoeings in July and August, but after that will require no further treatment until harvest, though a hoeing in September after the close of monsoon is useful to conserve the moisture. It is probable that the crop could also be sown broadcast at a slightly greater seed rate in September on *Kulthi* and *Kalai* lands to take the place of these crops. The late varieties (Types I—IV) flower in October and their yield will be considerably decreased if the land dries before that time. The plants will be ready for harvest after the middle of December and should be harvested before they are fully ripe as the

seed sheds easily. The late varieties at present cultivated in the plains are unsatisfactory, in that their twining habit makes intercultivation difficult and their long growing period prevents the ground from being used for two crops in the year, besides which they harbour rats during October to December.

The usual method of cultivation of soy beans in the Darjeeling hills is described by Goodwin (13) as follows:—"After the maize crop has received the second hoeing and the weeds have been carefully buried the seed is sown among it at the rate of 40 lbs. per acre in June or the beginning of July. After the maize has been harvested the top parts of the stalks are cut off and carried away, and the Bhetmas crop is then hand weeded. The weeds may be pulled up and laid on the ground if the crop is not very thick, but they are often tied on to the maize stalks which have been left standing. After weeding the crop soon covers the ground with a mass of luxuriant vegetation, the appearance of which is very fine. Soy bean ripens in November. The leaves usually fall off before the crop is harvested and add to the manurial residue left by the roots, the nodules of which are very conspicuous." Goodwin has found that the Nepali variety does not do well if grown with maize, but sown by itself in drills 1 foot apart in April, it yielded 26 mds. (approx. 1 ton) per acre. Soy beans are also grown along the banks round the paddy fields in Kalimpong.

7. YIELD.

The tables given below show the actual yields obtained in experiments carried out in Bengal during the past year on unmanured land. The results of the experiments at Chinsurah and Cuttack have been supplied by Mr. F. Smith, and those of the Sabour, Bankipur and Dumraon farms by Mr. G. Sherrard, while all the information concerning the cultivation of soy beans in Kalimpong has been obtained from Mr. P. Goodwin. It will be seen that the yield usually varies from 8—12 mds. (approximately 650—1,000lbs.), but under favourable circumstances it may go up to over 26 mds. (over 2,200lbs.) per acre. It may be noted that these yields are much superior to those previously

Yield of the Types of Soy Beans found in Bengal, Bihar and Orissa.

Variety.	Where grown.	Dates of sowing.	Area sown.	Approximate yield per acre in lbs.	Corresponding yield in Mds. Srs. & Chtks.	Remarks.
					Mds. Srs. Ch.	
Type 1.—Black seed. Some of the black seed was collected from Bankipur Division and gave a very poor germination.	Sabour B. E. A. ...	June 7, 1911	0·22 acre	492	5 39 0	Germination poor.
	,, Farm ...	July 9, 1911	1·0 ,,	642	7 33 0	Water-logged.
	Bankipur Farm. A II	May 31, 1911	0·1 ,,	1,110 (½ ton approx.)	13 20 0	.....
	,, ,, D II	June 29, 1911	0·5 ,,	330	4 0 0	Heavy low land.
	Dumraon Farm ...	July 10, 1911	0·5 ,,	263	3 8 0	.....
	Chinsura Farm I ...	June 10, 1911	0·31 ,,	710	8 23 0	Clay loam.
	,, ,, II ...	July 1, 1911	0·2 ,,	900	10 37 0	Loam.
	Cuttack ...	June 12, 1911	0·2 ,,	452	5 20 0	From 2 separate plots each 0·2 acre.
Type 1-A.—Kalimpong seed.	Kalimpong Farm ...	1911	1·0 ,,	382	4 26 0	With Maize.
Type 3.—Yellow ...	Sabour B. E. A. ...	June 7, 1911	·19 ,,	903	10 39 0	.....
	,, Farm ...	July 9, 1911	1·0 ,,	888	10 32 0	Water-logged.
	Chinsura Farm I ...	June 10, 1911	0·31 ,,	700	8 20 0	Clay loam.
	,, ,, II ...	July 1, 1911	0·2 ,,	1,008	12 10 0	Loam.
Type 3-A.—Greeny yellow Kalimpong Farm. (Kalimpong).	Kalimpong Farm ...	1911	1·22 ,,	1,308	15 36 0	With Maize.
Type 4.—Chocolate ...	Sabour B. E. A. ...	June 7, 1911	0·23 ,,	1,102	13 16 0	.....
	,, Farm ...	July 9, 1911	1·0 ,,	781	9 20 0	.....
	Bankipur Farm A. I ...	May 31, 1911	·1 ,,	2,164	26 12 0	.....
	,, ,, D. I ...	June 29, 1911	·5 ,,	802	9 30 0	Heavy low land.
	Dumraon Farm ...	July 10, 1911	·5 ,,	493	6 0 0	.....
	Cuttack Farm ...	June 12, 1911	0·2 ,,	823	10 0 0	4 mds. 10 srs. were obtained in a second plot 0·2 acre at Cuttack.
Type 4-A.—Pale chocolate (Kalimpong).	Kalimpong Farm ...	1911	·5 ,,	806	9 32 0	
Type 5.—Barmeli ...	Kalimpong Farm ...	1910	.....	1,226	14 35 0	.....
	Chinsura Farm I ...	June, 1911	.....	1,028	12 20 0	Clay loam.
	,, ,, II ...	July, 1911	.....	559	6 31 0	Germ poor, loam.
	Kalimpong ...	1911	·5 acre.	1,366	16 24 0	.....
	,, ...	1911	2·0 acres.	880	10 28 0	With Maize.
Type 6.—Nepali ...	Kalimpong ...	April, 1911	·25 acre.	2,189	26 24 0	.....
	,, ..	1910	·25 ,,	214	2 24 0	With Maize.

Note.—These yields were obtained on unmanured land.

obtained in India (10). In China (12) the yield is said to vary from 400—600lbs. per acre in the poorer districts along the Yellow Sea coasts up to 2,000lbs. per acre in the Tichling district.

The cost of cultivation to produce a crop of 8—12 maunds should not be greater than Rs. 10—15 per acre in the plains, though it may be increased to Rs. 20 per acre if many weedings are given. One or at most two weedings are probably sufficient if the crop has germinated well. At Kalimpong, Goodwin (13) produced a crop of 17 maunds 12 seers (approximately 1,420lbs.) grain at a cost of Rs. 22 annas 8 for cultivation (excluding rent).

8. PRICE.

Although experiments are being made all over the world on the possibility of establishing soy beans as a paying crop, yet it would appear that Manchuria is still the only source from which they are obtained in large quantities.

Up till recent years the prices of Manchurian soy beans have been so small that it was unlikely to pay to grow the crop in other parts of the world. There is, however, an indication that the prices are steadily rising and, in fact, while in the autumn of 1908 the price was only £4-15 in England it went up to as much as £8-5 per ton towards the end of 1910 (Shaw 10). At the same time the price of oil went up to £30 per ton and the soja meal, obtained after extracting the oil, was sold at about £6-10* per ton.

Now by purchasing and selling at these rates, the manufacturer would have paid for 100 tons, £825. It may be assumed that some 13 tons of oil and 87 tons of meal could have been obtained from this which would have sold for £390 and £565-10 respectively. His gross receipts therefore on 100 tons, at these rates, would have been £955-10, and his gross profits about £130. This would have allowed £1-6 per ton for cost of manufacture and profit, which would be equivalent

* We have recently received a letter from England quoting the price of coarse meal at £7-5 and fine meal at £7-6 per ton from May to August 1912. We are indebted for this information to the courtesy of the Hull Oil Manufacturing Company, Limited.

to about 16% of the cost price. This is not sufficient margin to allow us to assume that higher prices could be given for the raw material, unless an increased price were obtained either for the oil or the meal.

It would appear, however, that £6-10 per ton is a ridiculously low price to pay for a food of such concentrated feeding quality as soy bean meal. The former cheapness of the meal has been due probably to the fact, that until quite recently it was found impossible to remove the objectionable odour due to the solvents used in extracting the oil. Of late, however, a meal has been put on the market which has not any trace of smell of the solvents used, and it is possible that the advent of this meal will raise the price of the product to a considerable extent, and enable the manufacturer to pay better prices for the raw material.

As prices are at present, it would appear doubtful whether the growth of the soy bean crop could be extended for export purposes. Our experiments appear to point out that yields of 8—12 maunds per acre may be expected with reasonable care, and at the present time prices of Rs. 3/- to 3/4 per maund free on rail is required by the few growers of indigenous soy beans. This works out at about £5-8 to £5-17 per ton. The reason for this high rate is not that the cost of cultivation is high as it is probable that in Bihar it should not exceed Rs. 10/- to 15/- per acre. The crop, however, is a difficult one in that it is on the land much longer than other pulses, and that it has in consequence to pay rent for two seasons. This difficulty may be met by the introduction of early ripening varieties, but of this we are unable to speak with certainty. Unless a higher yield or an earlier ripening variety can be obtained, however, there would appear to be little possibility of making sufficient profit at the price of Rs. 2-8 per maund or £4-10 per ton which is offered by merchants in Calcutta.

There can be no doubt that the crop is intrinsically worth more than this, for it has been shown that, with reasonable prices for the oil and meal, the manufacturer can obtain over £9-10 per ton for the seed after manufacture.

Also it has been pointed out already that the present price of £7-5 per ton for the meal is only for meal as cattle food. If success crowns the recent attempts to put the meal on the market for biscuit and cake manufacture it is evident that the manufacturer will ask for more than £7-5 per ton for the fine meal.

With the price of the coarsest wheat flour at £10 to £11 per ton it may be assumed that the manufacturer will be justified in asking for soy bean flour, which is much more nutritious, at least £8 to £10 per ton. With the price at the lower figure from 100 tons of seed the manufacturer would get 87 tons of meal worth £696 and 13 tons of oil worth £390 or £1,086 worth of manufactured products. In this way he would get nearly £11 per ton of seed which should allow him easily to pay the £9 per ton in England required to bring the price up to £7 per ton or Rs. 4 per maund in Calcutta.

It will, therefore, be seen from what precedes that if the growth of soy beans is to spread in India we must obtain either :—

(*a*) Higher prices from the manufacturers.

(*b*) Higher yields of seed per acre and earlier ripening varieties.

It would appear that neither of these conditions is impossible, but it is uncertain whether either will be fulfilled.

9. USES.

Food-stuff :—In Bengal soy beans are used very little for food as they are said to be too heat producing. It is usually taken after frying over a heated sand bath as *bhunja*, but it is also heated, crushed, and then used as *dal*, and also as *larua* mixed with *gur*.

The high percentage of nitrogen and oil in this pulse should make it a particularly valuable addition to a rice diet as a preventative of *beri-beri*. That there are a number of other ways of preparing soy beans for food in addition to those mentioned above can be seen from the following extracts from Shaw's Soy Bean in Manchuria (10) which are quoted here at length for the benefit of those desirous of experimenting with soy beans as an article of diet.

"In the Far East the beans are put to a variety of uses :—(*a*) As a food-stuff they are made into—

I. Bean sauce, or soy, called in Japan "*shoyu*" (whence the name "soya") and in China, *chiang-yu*. It is made by boiling the beans, adding an equal quantity of wheat or barley, and leaving the mass to ferment : a layer of salt and three times as much water as beans are afterwards put in, when the liquid is pressed and strained. The following method is more scientific and cleanly than the native way :—Equal weights of beans, coarse barley meal, and salt should be taken, the beans washed and boiled until tender, and pounded in a mortar, the barley meal being added gradually. The mass should then be placed in an earthenware bowl and covered with a cloth, to be stood in a warm place for several days, until it is sufficiently fermented, but not mouldy. The salt is then dissolved in water and stirred into the mass, which must be kept closely covered for three months, during which time it must be stirred for one hour daily. At the end of this time it is strained through a fine cloth, as much of the moisture as possible being extracted by pressure ; after it has become clear the sauce is ready for use.

II. The Chinese paste *chiang*—not the same article of diet as the Japanese paste *miso*. It is made by farmers, and eaten with fish, meat, and vegetables, while the more expensive Chinese soy is only made by wealthy families and restaurant-keepers and is not consumed by the very poor.

There are two kinds of *chiang : ta* (great) and *hsiao* (small). The former is made in the following way :—The ingredients—1 *tou* of yellow beans and 2 *tou* of water—are boiled until the mass of the former can be readily crumbled in the fingers. It is next ground with a wooden pestle in a tub into the shape of a pan-cake, and laid on a mat in a cool place for fermentation, which is complete at the end of two months. The fermented mass is then re-ground to powder and 4 *sheng* (native pints) of salt with water are added, after which it is placed in the open and stirred occasionally. As the water evaporates more must be added and in 15 days the mixture is ready for consumption.

Hsiao chiang is made in the same way, but the ingredients are 1 *tou* 1 *sheng* (1 peck and 1 pint) of beans to 1 *sheng* of maize, to which 5 *sheng* of salt are added.

III. *Tou-fu*, or beancurd—made from green or yellow beans, the first giving greater quantity but poorer quality. The beans are steeped in water until they swell considerably, then ground in a stone mill, and passed through a strainer which retains the epidermis of the beans; after which they are boiled in a pot, poured off into a jar, and well diluted brine added to them—this being stirred in, causes coagulation of the proteid compound legumin or vegetable casein, and the mixture is ready to be drained off in an hour and cut into blocks for sale."

Some trials of the value of soy beans as a green vegetable carried out by Mr. Sil at Sabour showed that the pods were unpleasantly fibrous.

Oil :—The chief use of the oil is for soap-making, and it is for the extraction of the oil for this purpose that the seeds are being imported into England on a large scale. In China (13) the oil is used as an illuminant, as a substitute for lard in cooking, though it is inferior to rapeseed and sesamum oil for this purpose, as a lubricant for greasing cart axles, and for waterproofing cloth.

Cake and Flour :—The flour is already utilized for the manufacture of biscuits and should prove a valuable food-stuff as it contains a high percentage of nitrogen. The bean cake has given results equal to decorticated cotton cake in a number of feeding trials with milch cows (15).

10. GENERAL CONCLUSIONS.

At the present time Soy Beans are grown to a slight extent only in the Darjeeling hills and to no appreciable extent elsewhere although satisfactory yields have been obtained in the experiments conducted by the Agricultural Department in both these areas. We may ascribe the present unpopularity of the crop to the following reasons. For export the price offered in Calcutta is not yet sufficiently attractive; as a food-stuff it is

more potent than the ordinary pulses to which the people are accustomed; as a crop for growth in the plains it has the disadvantage of occupying the land during two seasons, it may suffer from water-logging during the rains and requires plenty of moisture in October, and it harbours rats during the last two months of its growth. These objections do not appear to us by any means unsurmountable. We have already shown that there are good prospects of an increase of price of Soy Bean meal, which should enable manufacturers to pay more for their raw material. The use of Soy Beans for food could be extended if the educated classes once appreciate its value as an addition to a rice diet, and experiment with its preparation for food on the lines suggested. As a field crop in the plains it can suitably replace *Urd* or *Kalai* (Phaseolus Mungo, Linn) as a mixed crop with Maize, in which case the maize would be harvested in September and the Soy Beans in December. It could also take the place of the *Kulthi* (Dolichos biflorus) and sometimes *Kalai*, which are sown on large areas of high lands in September and which do not give very heavy or profitable crops. Its cultivation in the hills would probably be largely extended on the present lines as soon as the price reached a satisfactory figure. It only remains to say that our work is being continued on the lines indicated in this paper with a view to isolating early maturing types possessing a high yield of oil.

We are much indebted to our Assistants, Mr. A .C. Ghosh, Asst. Economic Botanist, and Mr. M. N. Ghosh, Asst. Professor of Chemistry, for assistance in carrying out this work.

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BLACK SOY BEANS.

Table I.

Table showing the history of descendants of various singly selected plants.

	1909.		1910.		1911.		Oil.		Remarks.
	No. of plants.	Nitrogen.	No. of plants.	Nitrogen.	No. of plants.	Nitrogen.	1910.	1911.	
135 A ...	1	6·08	9	6·27	103	6·58	...	12·36	Type 1.
135 B ...	1	5·92	6	6·88	49	6·09	...	13·34	
135 C ...	1	6·43	4	6·77	65	6·20	...	12·22	
E_1/26 ...	...	...	1	7·49	6	6·27	14·30	12·24	These were selected in 1910 for abnormalities in nitrogen and oil contents but their descendants were found to be normal.
E_1 35 ...	...	...	1	6·11	5	6·55	15·38	11·18	
E_1/39 ...	...	..	1	6·10	53	6·22	14·22	13·50	
E_1/65 ...	...	...	1	5·95	47	6·49	14·86	13·14	
256 A ...	...	...	1	7·44	36	6·05	...	12 84	Type 2.
256 B ...	...	...	1	7·23	6	6·11	...	13·34	These were selected in 1910. They appeared to ripen early and gave small seeds. The nitrogen contents were also very high. Their descendants have been found to return to the normal in this particular. The oil contents are also normal.
256 C ...	...	...	1	7·70	8	6·52	...	12·66	
256 D ...	...	...	1	6·87	6	6·43	...	12·42	
256 F ..	...	...	1	6·66	55	6·54	...	12·48	
256 G ...	..	...	1	7·44	16	6·24	...	13·36	
256 H ...	...	..	1	6·74	32	6·08	...	14·27	
256 (bulked)	...	...	23	7·04	59	6·32	...	13·42	

YELLOW SOY BEANS (TYPE 3).

TABLE II.

Table showing history of descendants of various singly selected plants.

Original No.	1909.		1910.		1911.		OIL.		REMARKS.
	No. of plants.	Nitrogen.	No. of plants.	Nitrogen.	No. of plants.	Nitrogen.	1910.	1911.	
95 A ...	1	5·99	?	5·67	186	5·83	...	16·30	
95 B ...	1	5·93	21	5·79	182	5·52	...	15·95	
95 C ...	1	5·60	6	5·65	117	5·77	...	16·90	
E_3/33 ...	...	...	1	6·14	32	5·96	16·38	15·48	These were selected in 1910 as being abnormal in nitrogen or oil content. In every case their descendants have shown a tendency to revert to the mean.
E_3/55 ...	...	...	1	6·08	9	5·37	18·14	17·52	
E_3/60 ...	...	...	1	6·10	18	5·87	15·98	16·88	
E_3/77 ...	...	...	1	6·11	9	5·41	17·22	16·19	
E_3/83 ...	..	...	1	4·80	4	5·73	19·06	17·52	
E_3/86 ...	...	...	1	5·47	5	5·48	17·76	17·28	
E_3/101 ...	...	...	1	6·18	4	5·81	16·12	16·48	
E_3/131 ...	...	...	1	5·01	4	5·77	17·06	16·36	
E_3/145 ...	...	...	1	4·90	14	5·65	19·32	16·50	

CHOCOLATE SOY BEANS (TYPE 4).

TABLE III.

Table showing history of descendants of various singly selected plants.

Original No.	1909.		1910.		1911.		OIL.		REMARKS.
	No. of plants.	Nitrogen.	No. of plants.	Nitrogen.	No. of plants.	Nitrogen.	1910.	1911.	
94 A ...	1	5·32	2	5·91	180	6·06	.....	16·44	
94 B ...	1	5·44	19	5·85	306	5·93	.....	17·16	
94 C ...	1	4·83	24	5·80	1,227	6·01	.....	16·03	For analyses of the progeny of each of the 24 single plants in 1911, see Table IV.
E2/1 ...	...	...	1	4·93	6	5·60	17·62	15·56	These were selected in 1910 as having nitrogen content below normal and oil above normal. All show a tendency to revert to the normal in both cases.
E2/3 ...	...	...	1	4·75	48	5·89	18·22	17·28	
E2/5 ...	...	...	1	4·73	43	5·45	19·16	16·10	
E2/82 ...	...	...	1	4·83	23	5·74	19·30	16·66	
E2/83 ...	...	...	1	5·07	37	5·96	19·44	17·34	
E2/86 ...	...	...	1	4·93	14	5·67	19·38	16·08	

TABLE IV.

Table showing variations in 24 plots grown from each plant descended from sowing of seed from the single plant No. 94c.

Serial No.	No. of plants.	Nitrogen.	Variation from mean.	Oil.	Variation from mean.	REMARKS.
1	95	5·82	−·19	16·94	+·91	
2	48	6·05	+·04	17·30	+1·27	
3	62	6·06	+·05	15·80	−·21	
4	46	5·58	−·43	15·56	−·45	
5	41	6·07	+·06	15·38	−·63	
6	87	6·00	−·01	15·26	−·75	
7	123	6·18	+·17	16·66	+·65	
8	33	6·02	+·01	16·28	+·27	
9	31	6·11	+·10	15·20	−·81	
10	26	6·15	+·14	16·30	+·29	
11	59	6·09	+·08	15·90	−·11	
12	61	5·74	−·27	15·12	−·89	
13	84	5·94	−·17	14·84	−1·17	
14	68	6·11	+·10	15·98	−·03	
15	32	5·82	−·19	15 86	−·15	
16	43	5·95	−·07	15·96	−·05	
17	40	5·87	−·14	15·84	−·17	
18	134	6·14	+·13	16·40	+·39	
19	38	6·00	−·01	16·10	+·09	
20	17	6·16	−·15	16·68	+·67	
21	70	6·04	+·03	16·20	+·19	
22	51	6·22	+·21	15·34	−·67	
23	26	6·07	+·06	17·58	+1·57	
24	12	5·98	−·03	16·36	+·35	
Mean	...	6·01	...	16·03	..	

It will be seen from this Table that the variations are very small. In the case of the nitrogen determinations 13 are within the limits 6·01 ± ·1 making the probable error only ± ·1 and in the oils 13 lie within the limits 16·03 ± ·5% pointing to a probable error of ± ·5%.

Table V.

Detailed table showing the results obtained with 150 *samples of black soy beans analysed in* 1911.

No.	Nitrogen Percentage.	Oil Percentage.	Oil Percentage on the dry substance.	Remarks.
E—1 / P—1 of 10 ...	6·80	.....	This was determined in certain cases but was found to make no difference to our conclusions. In consequence the percentage of oil and nitrogen on undried substance has been inserted in the letterpress.	
E—1 / P—2 ...	6 68	.....		
E—1 / P—3 ...	7·54	14·26		
E—1 / P—4 ...	6·50	.....		
E - 1 / P—5 ...	Spoilt	.....		
E—1 / P—6 ...	6·54	.....		
E—1 / P—7 ...	6·90	.....		
E—1 / P—8 ...	6·23	.....		
E—1 / P—9 ...	6·25	.....		
E—1 / P—10 ...	6·20	.....		
E—1 / P—11 ...	7·66	14·24		
E—1 / P—12 ...	7·03	.....		
E—1 / P—13 ...	7·05	13·32	15·45	
E—1 / P—14 ...	6·92	.....	.....	
E—1 / P—15 ...	7·34	13·92	.....	

TABLE V—*contd.*

No.	Nitrogen percentage.	Oil percentage.	Oil percentage on the dry substance.	REMARKS.
E—1 / P—16 ...	6·63	13·86	16·14	
E—1 / P—17 ..	7·07	.....	.. ...	
E—1 / P—18 ...	6·61	.....	.....	
E—1 / P—19 ...	6·86	13·38	15·50	
E—1 / P—20 ...	6·80	13·62	15·80	
E—1 / P—21 ...	7·30	13·96	.....	
E—1 / P—22 ...	7·19	13·28	15·02	
E—1 / P—23 ...	7·67	11·76	12·72	
E—1 / P—24 ...	7·01	.....	.....	
E—1 / P—25 ...	6·57	13·50	15·18	
E—1 / P—26 ...	7·40	14·30	.....	
E—1 / P—27 ...	6·97	14·38	.....	
E—1 / P—28 ..	7·00	13·88	.....	
E—1 / P—29 ...	7·29	.....	.....	
E—1 / P—30 ...	6·22	.....	.....	
E—1 / P—31 ...	6·69	.....	.....	

TABLE V—*contd.*

No.	Nitrogen percentage.	Oil percentage.	Oil percentage on the dry substance.	REMARKS.
E—1/P—32 ...	6·58	.....	.....	
E—1/P—33 ...	6·51	.....	.....	
E—1/P—34 ...	7·35	14·06	.....	
E—1/P—35 ...	6·11	15·38	.....	
E—1/P—36 ...	6·41	.....	.....	
E—1/P—37 ...	7·12	.....	.....	
E—1/P—38 ...	6·61	.....	.....	
E—1/P—39 ...	6·10	14·22	.....	
E—1/P—40 ...	6·55	.....	.....	
E—1/P—41 ...	6·29	.....	.....	
E—1/42 ...	6·43	15·10	.....	
E—1/43 ...	6·20	14·22	.....	
E—1/44 ...	6·61	13·94	.....	
E—1/45 ...	7·28	12·60	.....	
E—1/46 ...	6·55	16·28	.....	
E—1/47 ...	6·78	12·82	.....	

TABLE V—*contd.*

No.	Nitrogen percentage.	Oil percentage.	Oil percentage on the dry substance.	REMARKS.
E—1/48 ...	6·75	12·76	.....	
E—1/49 ...	6·46	13·54	.....	
E—1/50	7·09	14·02	.....	
E—1/51 ...	6·43	13·04	.....	
E—1/52 ...	7·03	15·08	.....	
E—1/53 ...	6·23	15·24	.....	
E—1/54 ...	6·48	12·40	.....	
E—1/55 ...	6·33	14·56	.....	
E—1/56 ...	Spoilt	13·50	.....	
E—1/57 ...	6·71	11·74	.....	
E—1/58 ...	5·86	13·66	.....	
E—1/59 ...	6·11	15·06	.....	
E—1/60 ...	6·32	13·52	.....	
E—1/61 ...	6·25	13·02	.....	
E—1/62 ...	6·25	14·06	.....	
E—1/63 ...	6·25	13·62	.....	

TABLE V—*contd.*

No.	Nitrogen percentage.	Oil percentage.	Oil percentage on the dry substance.	REMARKS.
E—1/64 ...	6·66	13·62	.....	
E—1/65 ...	5·95	14·86	.....	
E—1/66 ...	6·76	13·48	.....	
E—1/67 ...	7·03	13·10	.....	
E—1/68 ...	6·73	12·82	.....	
E—1/69 ...	6·87	13·30	.....	
E—1/70 ...	6·53	14·02	.....	
E—1/71 ...	6·37	12·88	.....	
E—1/72 ...	7·19	13·33	.....	
E—1/73 ...	7·06	12·85	14·69	
E—1/74 ...	6·46	13·20	.....	
E—1/75 ...	6·46	13·58	.....	
E—1/76 ...	6·74	12·96	.....	
E—1/77 ...	Spoilt	13·14	15·24	
E—1/78 ...	6·21	13·28	15·50	
E—1/79 ...	.....	13·48	15·50	

TABLE V—*contd.*

No.	Nitrogen percentage.	Oil percentage.	Oil percentage on the dry substance.	REMARKS.
E—1/80 ...	6·61	14·45	16·30	
E—1/81 ...	6·50	14·16	15·95	
E—1/82 ...	6·49	11·34	.....	
E—1/83 ...	6·76	13·18	14·30	
E—1/84 ...	6·61	.....	.....	
E—1/85 ...	6·58	11·12	13·02	
E—1/86 ...	6·14	12·78	14·80	
E—1/87 ...	6·07	15·44	.....	
E—1/88 ...	.....	.....	.....	
E—1/89 ...	6·55	.....	.....	
E—1/90 ...	6·78	10·48	11·70	
E—1/91 ...	6·79	.....	.....	
E—1/92 ...	.....	.....	.....	
E—1/93 ...	6·62	.....	.....	
E—1/94 ...	7·07	.....	.....	
E—1/95 ...	6·50	.....	.....	

TABLE V—*contd.*

No.	Nitrogen percentage.	Oil percentage.	Oil percentage on the dry substance.	REMARKS.
E—1/96 ...	6·81	11·65	13·77	
E—1/97 ...	6·72	14·06	16·40	
E—1/98 ...	6·60	.....	.....	
E—1/99 ...	6·46	12·82	14·70	
E—1/100 ...	6·52	11·90	13·75	
E—1/101 ...	6·28	14·00	16·20	
E—1/102 ...	6·37	.....	.....	
E—1/103 ...	7·12	.....	.....	
E—1/104 ...	7·04	.....	.....	
E—1/105 ...	6·34	13·43	15·55	
E—1/106 ...	6·33	.....	.....	
E—1/107 ...	Spoilt.	.....	.....	
E—1/108 ...	7·18	12·98	15·08	
E—1/109 ..	6·60	.....	.....	
E—1/110 ...	6·69	.....	.....	
E—1/111 ...	6·99	12·42	14·40	

TABLE V—*contd.*

No.	Nitrogen percentage.	Oil percentage.	Oil percentage on the dry substance.	REMARKS.
E—1/112 ...	7·00	13·42	15·40	
E—1/113 ...	7·05	.....	.....	
E—1/114 ...	6·47	.....	.....	
E—1/115 ...	7·01	.....	.....	
E—1/116 ...	7·14	.....	.....	
E—1/117 ...	7·03	13·38	15·52	
E—1/118 ...	.....	.....	.....	
E—1/119 ...	.....	14·16	16·20	
E—1/120 ..	7·34	.....	.....	
E—1/121 ...	7·13	.....	.....	
E—1/122 ...	6·82	.....	.....	
E—1/123 ...	7·37	15·82	.....	
E—1/124 ...	6·80	.....	.....	
E—1/125 ...	6·72	.....	.....	
E—1/126 ...	6·96	.....	.....	
E—1/127 ...	7·09	.....	.....	

TABLE V—*contd.*

No.	Nitrogen percentage.	Oil percentage.	Oil percentage on the dry substance.	REMARKS.
E—1/128 ...	6·19	.....	.....	
E—1/129 ...	6 69	.....	.....	
E—1/130 ...	6·15	.....	.....	
E—1/131 ...	6·17	.....	.. .	
E—1/132 ...	6·94	.....	.....	
E—1/133 ...	6·30	.....	.....	
E—1/134 ...	6·15	... ..	.....	
E—1/135 ...	7·32	.....	.....	
E—1/136 ...	6·47	.. ...	.....	
E—1/137 ...	6·86	.....	.. ...	
E—1/138 ...	7·65	.....	.. ...	
E—1/139 ...	7·30	13·02	.....	
E—1/140 ...	7·36	12·06	...	
E—1/141 ...	6·69	.. ..	.....	
E—1/142 ...	6·28	... ..	.....	
E—1/143 ...	6·96	.....	.....	

TABLE V—*concld.*

No.	Nitrogen percentage.	Oil percentage.	Oil percentage on the dry substance.	REMARKS.
E—1/144 ...	6·48	...	...	
E—1/145 ...	7·20	...	...	
E—1/146 ...	6·93	...	...	
E—1/147 ...	6·82	...	...	
E—1/148 ...	6·69	...	...	
E—1/149 ...	6·58	...	...	
E—1/150 ...	6·61	...	...	

TABLE VI.

Detailed results obtained in 1911 *with* 150 *samples of yellow soy beans* (*Type* 3).

No.	Nitrogen percentage.	Oil percentage.	Oil percentage on the dry substance.	REMARKS.
E—3/1 ...	5·78	17·30	19·60	The oil content in the dry substance was calculated but was found to make no difference to our conclusions. In consequence, the actual percentages observed on the undried substance have been used in the letterpress.
E—3/2 ...	5·82	16·58	18·78	
E—3/3 ...	5·99	17·34	19·57	
E—3/4 ...	5·46	...	...	
E—3/5 ...	5·60	16·64	19·04	

TABLE VI—*contd.*

No.	Nitrogen percentage	Oil percentage.	Oil percentage on the dry substance.	REMARKS.
E—3/6 ...	5·52	17·22	19·68	
E—3/7 ...	5·76	16·98	19·38	
E—3/8 ...	5·34	16·84	19·29	
E—3/9 ...	5·76	16·78	18·95	
E—3/10 ...	5·53	.....	.....	The oil content in the dry substance was calculated but was found to make no difference to our conclusions. In consequence the actual percentages observed on the undried substance have been used in the letterpress.
E—3/11 ...	5·74	16·60	18·72	
E—3/12 ...	5·76	.....	.....	
E—3/13 ...	5·44	17·06	19·17	
E—3/14 ...	5·61	.....	.....	
E—3/15 ...	5·70	17·25	19·66	
E—3/16 ...	5·57	17·38	19·84	
E—3/17 ...	5·54	.....	.....	
E—3/18 ..	5·64	.....	.....	
E—3/19 ...	5·54	.....	.....	
E—3/20 ...	5·74	17·02	19·33	
E—3/21 ...	5·39	18·12	20·45	

TABLE VI—*contd.*

No.	Nitrogen percentage.	Oil percentage.	Oil percentage on the dry substance.	REMARKS.
E—3/22 ...	5·80	...	...	
E—3/23 ...	5·41	...	...	
E—3/24 ...	5·68	...	...	
E—3/25 ...	5·38	17·30	19·84	
E—3/26 ...	5·57	16·90	19·33	
E—3/27 ...	5·58	17·54	19·66	
E—3/28 ...	5·92	17·56	19·77	
E—3/29 ..	5·56	17·46	19·65	
E—3/30 ...	5·82	18·06	20·29	
E—3/31 ...	5·76	17·26	19·18	
E—3/32 ...	5·63	16·74	19·05	
E—3/33 ...	6·14	17·78	20·10	
E—3/34 ...	5·74	17·68	19·92	
E—3/35 ...	5·64	15·76	17·92	
E—3/36 ...	5·75	...	...	
E—3/37 ...	5·75	15·26	17·54	

TABLE VI—*contd.*

No.	Nitrogen percentage.	Oil percentage.	Oil percentage on the dry substance.	REMARKS.
E—3/38 ...	5·83	...	...	
E—3/39 ...	5·64	14·68	16·77	
E—3/40 ...	5·37	...	...	
E—3/41 ...	5·78	16·90	19·06	
E—3/42 ...	5·60	...	...	
E—3/43 ...	5·98	16·84	18·95	
E—3/44 ...	5·66	16·60	18·76	
E—3/45 ...	5·42	16·56	18·74	
E—3/46 ...	5·27	...	...	
E—3/47 ...	5·87	...	...	
E—3/48 ...	5·85	15·22	17·24	
E—3/49 ...	5·89	...	...	
E—3/50 ...	...	...	...	
E—3/51 ...	5·46	...	...	
E—3/52 ...	5·29	16·08	18·24	
E—3/53 ...	5·59	...	...	

TABLE VI—*contd.*

No.	Nitrogen percentage.	Oil percentage.	Oil percentage on the dry substance.	REMARKS.
E—3/54 ...	5·49	17·18	19·33	
E—3/55 ...	6·08	18·14	.....	
E—3/56 ...	5·88	16·90	18·84	
E—3/57 ...	5·89	17·80	19·84	
E—3/58 ...	5·98	.....	.....	
E—3/59 ...	5·50	18·02	20·09	
E—3/60 ...	6·10	15·98	.....	
E—3/61 ...	5·63	.....	.....	
E—3/62 ...	5·90	.....	.....	
E—3/63 ...	5·81	.....	.....	
E—3/64 ...	5·74	.....	.....	
E—3/65 ...	5·85	17·86	19·87	
E—3/66 ...	5·83	.....	.....	
E—3/67 ...	5·29	.....	.....	
E—3/68 ...	5·91	.....	.....	
E—3/69 ...	5·39	18·10	19·88	

TABLE VI—*contd.*

No.	Nitrogen percentage.	Oil percentage.	Oil percentage on the dry substance.	REMARKS.
E—3/70 ...	5·47	.....	.....	
E—3/71 ...	5·51	.....	.....	
E—3/72 ...	5·82	14·20	15·62	
E—3/73 ...	5·52	.....	.....	
E—3/74 ...	5·63	.....	...	
E—3/75 ..	5·35	17·38	19·29	
E—3/76 ...	6·04	16·12	17 96	
E—3/77 ..	6·11	17·22	.....	
E—3/78 ...	5 85	.....	.....	
E—3/79 ...	5·53	.....	.....	
E—3/80 ...	5·89	.....	.....	
E—3/81 ...	5·80	16·70	18·42	
E—3/82 ...	5·95	.....	.....	
E—3/83 ...	4·80	19·06	.....	
E—3/84 ...	5·20	.....	.....	
E—3/85 ...	5·68	.....	.....	

TABLE VI—*contd.*

No.	Nitrogen percentage.	Oil percentage.	Oil percentage on the dry substance.	REMARKS.
E—3/86 ...	4·96	17·76	.....	
E—3/87 ...	5·46	.....	.....	
E—3/88 ...	5·75	.....	.....	
E—3/89 ...	5·74	.....	.....	
E—3/90 ...	5·17	.....	.....	
E—3/91 ...	5·68	.....	.....	
E—3/92 ...	5·84	.....	.....	
E—3/93 ...	5·47	.....	.....	
E—3/94 ...	5·92	.....	.....	
E—3/95 ...	5·43	.....	.....	
E—3/96 ...	5·50	.....	.....	
E—3/97 ...	5·79	.....	.....	
E—3/98 ...	5·74	.....	.....	
E—3/99 ...	5·65	.....	.....	
E—3/100 ...	5·82	15·96	17·74	
E—3/101 ...	6·18	16·12	.....	

TABLE VI—*contd.*

No.	Nitrogen percentage.	Oil percentage.	Oil percentage on the dry substance.	REMARKS.
E—3/102 ...	5·45	.....	.....	
E—3/103 ...	6·01	17·82	20·09	
E—3/104 ...	5·50	16·90	19·03	
E—3/105 ...	5·53	15·66	17·52	
E—3/106 ...	5·64	.....	.....	
E—3/107 ...	5·46	.....	.....	
E—3/108 ...	6·04	16·14	18·97	
E—3/109 ...	5·41	17·48	18·27	
E—3/110 ...	5·65	.....	.....	
E—3/111 ...	5·67	.....	.....	
E—3/112 ...	5·62	17·46	19·02	
E—3/113 ...	5·34	16·60	18·11	
E—3/114 ...	5·91	16·78	18·27	
E—3/115 ...	5·09	.....	.....	
E—3/116 ...	5·89	.....	.....	
E—3/117 ...	5·43	17·76	19·95	

TABLE VI—*contd.*

No.	Nitrogen percentage.	Oil percentage.	Oil percentage on the dry substance.	REMARKS.
E—3/118 ...	5·01	18·30	...	
E—3/119	5·33	16·36	18·37	
E—3/120 ...	5·27	17·10	19·20	
E—3/121 ...	5·76	.....	.....	
E—3/122 ...	5·78	.....	.....	
E—3/123 ...	5·58	.....	.....	
E—3/124 ...	5·50	17·46	19·63	
E—3/125 ...	5·55	.....	.....	
E—3/126 ...	5·77	.....	.....	
E—3/127 ...	5·76	.....	.....	
E—3/128 ...	5·60	.....	.....	
E—3/129 ...	5·77	.....	.....	
E—3/130 ...	5·74	.....	.....	
E—3/131 ...	5·01	17·06	.....	
E—3/132 ...	5·35	.....	.....	
E—3/133 ...	5·63	.....	.....	

TABLE VI—*concld.*

No.	Nitrogen percentage.	Oil percentage.	Oil percentage on the dry substance.	REMARKS.
E—3/134 ...	5·40	.....	.....	
E—3/135 ...	5·77	.....	.....	
E—3/136 ...	5·38	.....	.....	
E—3/137 ...	5·49	.....	.....	
E—3/138 ...	5·55	.....	.....	
E—3/139 ...	5·80	.....	.....	
E—3/140 ...	5·53	.....	.....	
E—3/141 ...	5·33	.....	.....	
E—3/142 ...	5·56	.....	.....	
E—3/143 ...	5·40	.....	.....	
E—3/144 ...	5·43	.....	.....	
E—3/145 ...	4·90	19·32	.....	
E—3/146 ...	5·12	.....	.....	
E—3/147 ...	5·24	.....	.....	
E—3/148 ...	5·69	.....	.....	
E—3/149 ...	5·73	.....	.....	
E—3/150 ...	5·34	.....	.....	

Table VII.

Results obtained in 1911 with 152 samples of chocolate soy beans (Type 4).

No.	Nitrogen percentage.	Oil percentage.	Oil percentage on the dry substance.	Remarks.
E—2/1 ...	4·93	17·62	19·55	
E—2/2 ...	5·66	17·67	19·88	The oil content in the dry substance was calculated, but was found to make no difference to our conclusions. In consequence the actual percentages observed in the undried substance have been used in the letter-press.
E—2/3 ..	4·75	18·22	20·00	
E—2/4 ...	5·57	16·46	18·62	
E—2/5 ...	4·73	19·16	20·75	
E—2/6 ...	5·54	16·42	18·64	
E—2/7 ...	5·35	16·00	18·13	
E—2/8 ...	5·42	16·51	16·65	
E—2/9 ...	7·08	.....	...	
E—2/10 ...	Spoilt.	.....	.....	
E—2/11 ...	5·55	.....	.....	
E—2/12 ...	4·92	18·16	19·89	
E—2/13 ...	5·88	...	.....	
E—2/14 ...	5·46	16·90	18·73	
E—2/15 ...	5·57	16·94	19·28	

TABLE VII—*contd.*

No.	Nitrogen percentage.	Oil percentage.	Oil percentage on the dry substance.	REMARKS.
E—2/16 ...	Spoilt.	16·34	18·61	
E—2/17 ...	5·24	.....	.....	
E—2/18 ...	6·00	15·60	17·61	
E—2/19 ...	5·68	16·40	18·52	
E—2/20 ...	5·36	17·08	19·12	
E—2/21 ...	5·65	.....	.....	
E—2/22 ...	5·44	17·26	19·39	
E—2/23 ...	5·44	16·56	18·68	
E—2/24 ...	5·49	17·62	19·95	
E—2/25 ...	5·77	16·58	18·78	
E—2/26 ...	5·68	17·40	19·64	
E—2/27 ...	6·10	16·70	18·86	
E—2/28 ...	5·57	15·20	17·7	
E—2/29 ...	Spoilt.	.....	.....	
E—2/30 ...	5·35	16·06	18·27	
E—2/31 ...	4·98	.....	.....	

TABLE VII—*contd.*

No.	Nitrogen percentage	Oil percentage.	Oil percentage on the dry substance.	REMARKS.
E—2/32 ...	5·18	17·30	19·51	
E—2/33 ...	5·64	17·20	19·20	
E—2/34 ...	5·59	16·90	19·00	
E—2/35 ...	5·33	16·66	18·58	
E—2/36 ...	6·12	17·30	19·07	
E—2/37 ...	5·44	7·50	19·92	
E—2/38 ..	5·21	16·94	18·91	
E—2/39 ...	5·96	17·22	19·17	
E—2/40 ...	5·34	16·68	18·54	
E—2/41 ...	5·98	.....	.....	
E—2/42 ...	6·08	17·54	19·55	
E—2/43 ...	5·44	.....	.....	
E—2/44 ...	5·24	17·72	20·24	
E—2/45 ...	5·49	17·08	19·56	
E—2/46 ...	5·47	17·47	19·91	
E—2/47 ...	5·39	.....	.....	

TABLE VII—*contd.*

No.	Nitrogen percentage.	Oil percentage.	Oil percentage on the dry substance.	REMARKS
E—2/48 ..	5·28	16·88	19·31	
E—2/49 ...	5·33	.....	.....	
E—2/50 ..	5·24	17·08	19·31	
E—2/51 ...	5·80	16·40	18·43	
E—2/52 ...	5·24	.....	.....	
E—2/53 ...	5·72	.....	.....	
E—2/54 ...	5·41	17·80	19·97	
E—2/55 ...	5·32	18·32	20·52	
E—2/56 ...	5·48	16·58	18·81	
E—2/57 ...	5·53	.....	.. ...	
E—2/58 ...	6·23	15·84	17·97	
E—2/59 ...	5·57	16·78	18·71	
E—2/60 ...	5·82	17·16	19·14	
E—2/61 ...	6·03	16·28.	18·76	
E—2/62 ..	5·35	16·12	18·46	
E—2/63 ...	5·40	17·36	19·66	

TABLE VII—*contd.*

No.	Nitrogen percentage.	Oil percentage.	Oil percentage on the dry substance.	REMARKS.
E—2/64 ...	5·62	17·20	19·49	
E—2/65 ...	5·35	16·68	18·81	
E—2/66 ..	6·06	17·02	18·60	
E—2/67 ...	5 58	.....	.....	
E—2/68	5·61	16·80	18·94	
E—2/69 ...	5·38	.. ..	.....	
E—2/70 ...	5·84	16·28	18·63	
E—2/71	6 01	16·30	18 66	
E—2/72 ...	6·25	17·70	19·43	
E—2/73 ..	5·94	17·00	19·04	
E—2/74	5·42	.....	... ..	
E—2/75 ...	5·89	16·76	18·78	
E—2/76	5·41	... ..	.. ...	
E—2/77 ...	5·93	16·66	19·25	
E—2/78 ...	4·97	.....	.....	
E—2/79 ..	5·87	.. ...	.. ...	

TABLE VII—*contd.*

No.	Nitrogen percentage.	Oil percentage.	Oil percentage on the dry substance.	REMARKS.
E—2/80 ...	5·95	18·68	21·45	
E—2/81 ...	5·73	18·18	20·96	(Slight powder carried over.)
E—2/82 ..	4·83	19·30	21·11	Dry, analysed in hot weather.
E—2/83 ...	5·07	19·44	21·11	
E—2/84 ...	5·53	16·81	19·32	
E—2/85 ...	5·77	.....	.....	
E—2/86 ...	4·93	19·38	20·82	Dry, analysed in hot weather.
E—2/87 ...	5·33	.....	.....	
E—2/88 ...	5·35	17·20	19·61	
E—2/89 ...	5·30	.....	.....	
E—2/90 ...	5·16	18·06	20·66	
E—2/91 ...	5·89	17·86	20·41	
E—2/92 ...	5·56	17·12	19·89	
E—2/93 ...	5·80	16·80	19·46	
E—2/94 ...	5·66	17·38	19·73	
E—2/95 ...	5·89	.....	.....	

TABLE VII—*contd.*

No.	Nitrogen percentage.	Oil percentage,	Oil percentage on the dry substance.	REMARKS.
E—2/96 ..	6·04	15·72	17·86	
E—2/97 ...	5·81	16·98	19·23	
E—2/98 ..	5·93	.. ...	.....	
E—2/99 ..	6·01	.. ...	.....	
E—2/100 ...	5·21	. . ..	.....	
E—2/101 ...	Spoilt.	.....	. ...	
E—2/102 ...	5·41	.. ...	.....	
E—2/103 ...	5·72	.....	.....	
E—2/104 ...	5·49	... ..	. ...	
E—2/105 ...	5·77	.....	.....	
E—2/106 ...	5·58	.....	.....	
E—2/107 ...	5·73	.. ...	.....	
E—2/108 ...	5·66	.....	... ..	
E—2/109 ...	.....	.....	.....	
E—2/110 ...	.....	.....	.....	
E—2/111 ...	5·24	... ..	.....	

TABLE VII—*contd.*

No.	Nitrogen percentage.	Oil percentage.	Oil percentage on the dry substance.	REMARKS.
E—2/112 ...	5·89	.....	.....	
E—2/113 ...	5·96	.....	.....	
E—2/114 ...	5·45	.....	.....	
E—2/115 ...	6·06	.....	.....	
E—2/116 ...	5·55	.....	.....	
E—2/117 ...	5·76	.....	.....	
E—2/118 ...	5·64	.....	.....	
E—2/119 ...	5·10	.....	.....	
E—2/120 ...	5·53	.....	.....	
E—2/121 ...	.....	.....	.....	
E—2/122 ...	5·69	.....	.....	
E—2/123 ...	5·57	.....	.....	
E—2/124 ...	5·88	.....	.....	
E—2/125 ...	Spoilt.	.....	.....	
E—2/126 ...	5·75	.....	.....	
E—2/127 ...	6·00	.....	.....	

TABLE VII—*contd.*

No.	Nitrogen percentage.	Oil percentage.	Oil percentage on the dry substance.	REMARKS.
E—2/128 ...	5·88	.....	.....	
E—2/129 ...	5·19	.....	.....	
E—2/130 ...	5·12	.....	.....	
E—2/131 ...	5·42	.....	.....	
E—2/132 ...	4·86	.....	.....	
E—2/133 ...	5·83	.....	.....	
E—2/134 ...	5·98	.....	.....	
E—2/135 ...	5·67	.....	.....	
E—2/136 ...	5·87	.....	.....	
E—2/137 ...	5·65	.....	.....	
E—2/138 ...	5·36	.....	.....	
E—2/139 ...	5·37	.....	.....	
E—2/140 ...	5·26	.....	.....	
E—2/141 ...	5·31	.....	.....	
E—2/142 ...	5·59	.....	.....	
E—2/143 ...	5·20	.....	.....	

TABLE VII—*concld.*

No.	Nitrogen percentage.	Oil percentage.	Oil percentage on the dry substance.	REMARKS.
E—2/144 ...	5·09	...	... ..	
E—2/145 ...	5·58	.....	... ..	
E—2/146 ...	5·35	.....	.....	
E—2/147 ...	5·66	... ..	.....	
E—2/148 ...	5·85	.....	.....	
E—2/149 ...	5·46	.....	... ..	
E—2/150 ...	5·86	.....	.....	
E—2/151 ...	5·90	.....	.....	
E—2/152 ...	5·96	.....	... ..	

Table VIII.

Life periods of Bengal Varieties of Soy Beans grown in Bengal.

Variety.	Where grown.	Date of planting.	Date of harvesting.	Life period.	
Type 1. Late black seed.	Sabour ..	June 3, 1910	Dec. 20, 1910...	200 days	
	,, ...	,, 9, 1911	Dec. 19, 1911...	193 ,,	
	,, ...	July 12, 1911	Dec. 15, 1911...	156 ,,	
	Bankipur ...	June 1, 1911	Nov. 24 to 30, 1911.	177—183 days	
	Dumraon ...	July 10, 1911	Dec. 28, 1911...	171 days	
	Cuttack ...	June 12, 1911	Jany. 1912...	210 ,,	
	Chinsura ...	,, 10, 1911	Dec. 25, 1911...	199 ,, ...	on clay loam.
	,, ...	July 1, 1911	Dec. 28, 1911...	181 ,, ..	on loam.
Type 1*A*.	Kalimpong ...	June 15 to July 7, 1911	Nov. 16 to Dec. 2, 1911.	132—170 days	
Type 2. Early black seed.	Sabour ...	July 12, 1911	Nov. 26, 1911...	137 days	
Type 3. Yellow seed.	,, ...	June 3, 1910	Dec. 22, 1910...	202 ,,	
	,, ..	,, 9, 1911	,, 19, 1911...	193 ,,	
	,, ...	July 12, 1911	,, 20, 1911...	161 ,,	
	Chinsura ...	June 10, 1911	,, 25, 1911...	199 ,,	
	,, ...	July 1, 1911	,, 28, 1911...	181 ,,	
Type 3 *A*. Yellow seed.	Sabour ...	,, 12, 1911	Nov. 18 to Dec. 15, 1911.	129—156 days	
	Kalimpong ...	June 15 to July 7, 1911	Nov. 16 to Dec. 2, 1911.	132—170 days	
Type 4. Chocolate seed.	Sabour ...	June 3, 1910	Dec. 22, 1910...	202 days.	
	,, ...	June 9, 1911	Dec. 19, 1911...	193 ,,	
	,, ...	July 12, 1911	Dec. 20, 1911 ..	161 ,,	
	Bankipur ...	June 1, 1911	Nov. 24 to 30, 1911.	177—183 days.	
	Dumraon ...	July 10, 1911	Dec. 26, 1911...	169 days.	
	Cuttack ...	June 12, 1911	Jan. 7, 1912 ...	210 ,,	
Type 4 *A*. Pale chocolate.	Sabour ...	July 12, 1911	Nov. 18 to Dec. 13, 1911.	129—154 days.	
	Kalimpong ...	June 15 to July 7, 1911.	Nov. 16 to Dec. 2, 1911.	132—170 ,,	
Type 5. Barmeli	Sabour ...	July 12, 1911	Nov. 18, 1911...	129 days.	
	Kalimpong ...	June 27, 1910	,, 15, 1910 ..	141 ,,	
	,, ...	June 15 to July 7, 1911.	,, 16 to Dec. 2, 1911.	132—170 days.	
Type 6. Nepali	Sabour ...	July 12, 1911	Oct. 30, 1911	111 days.	
	Kalimpong ...	June 2, 1910	,, 6, 1910 ...	126 ,,	
	,, ...	May 10, 1911	,, 16, 1911 ...	159 ,,	

LIST OF PLATES.

Plate I ...	Type I ..	Late Black seeded variety—photographed, October 28, 1911.
Plate II ...	Type V .	Barmeli variety—photographed, October 28, 1911. *N. B.*—Some leaves have been removed to show the number of pods formed.
Plate III ...	Type VI ...	Nepali variety on left.
	Type IIIa ...	Upright long branched greeny yellow seeded variety on right.
Plate IV ...	...	Barchet variety—photographed, October 30, 1911. *N.B.*—The erect scale in each plate measures one metre.

PLATE I.

PLATE II.

PLATE III.

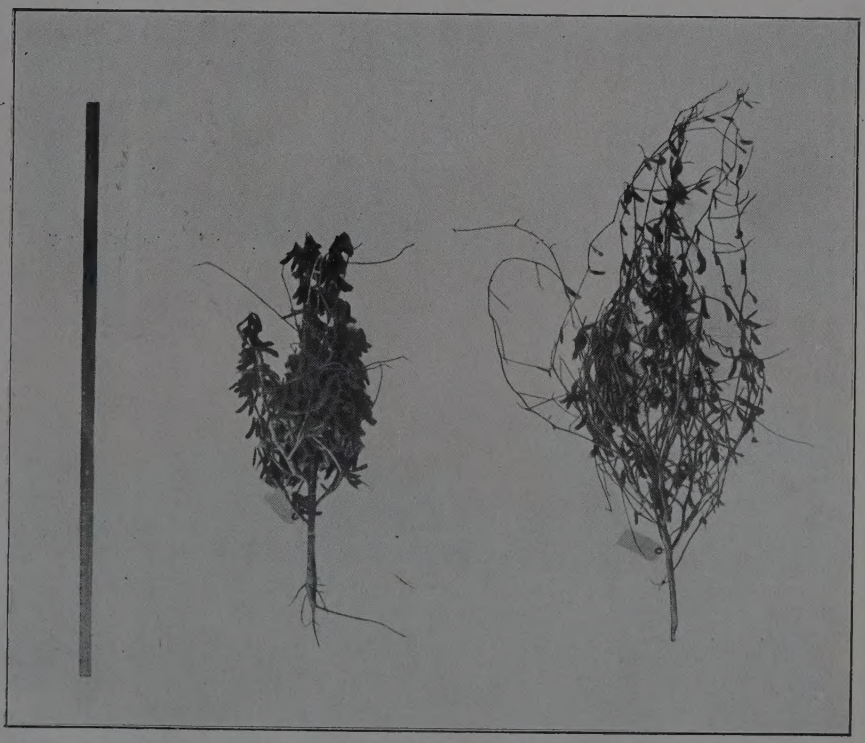

PLATE IV.